

Hazard Mitigation Program, State Hazard Mitigation Plan, and Current Projects

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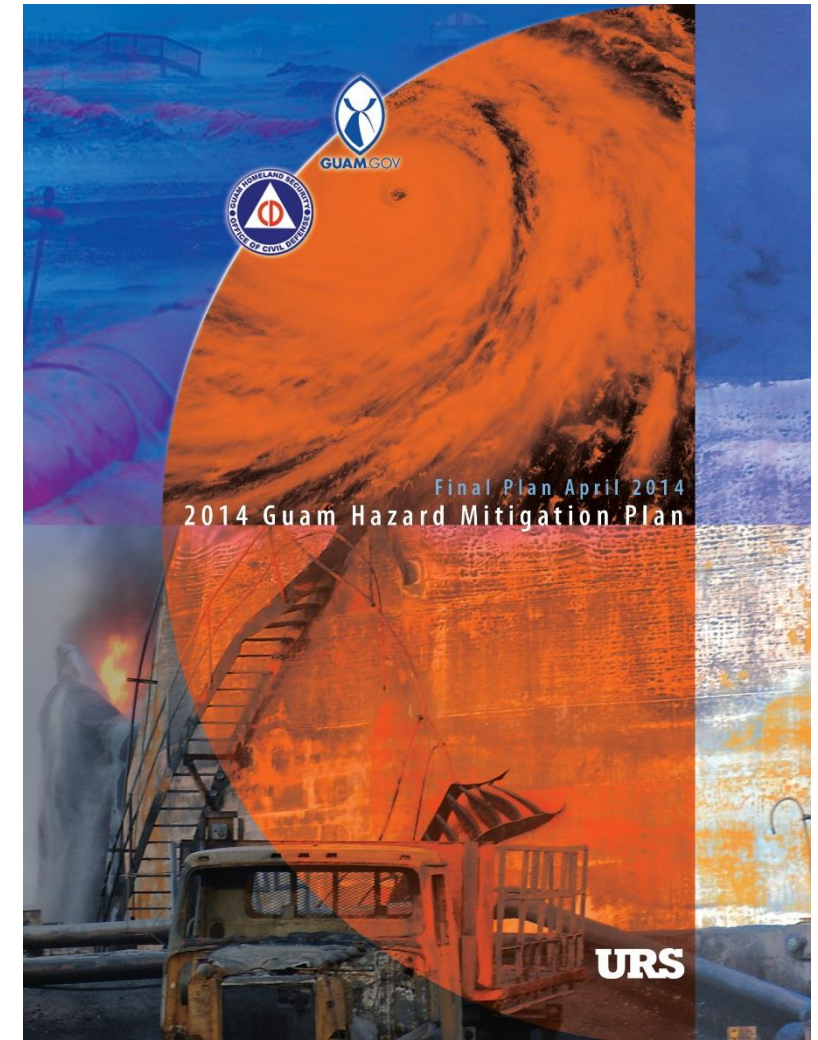
06 February 2019

Hazard Mitigation Program

- FEMA Hazard Mitigation Assistance (HMA) Program
 - Hazard Mitigation Grant Program (HMGP)
 - Flood Mitigation Assistance (FMA)
 - Pre-Disaster Mitigation (PDM) Grant Program
- NOAA/NWS National Tsunami Hazard Mitigation Program (NTHMP)
- FEMA National Earthquake Hazards Reduction Program (NEHRP)
- DHS/FEMA
 - Emergency Management Performance Grant (EMPG) Program
 - Homeland Security Grants Program (HSGP)

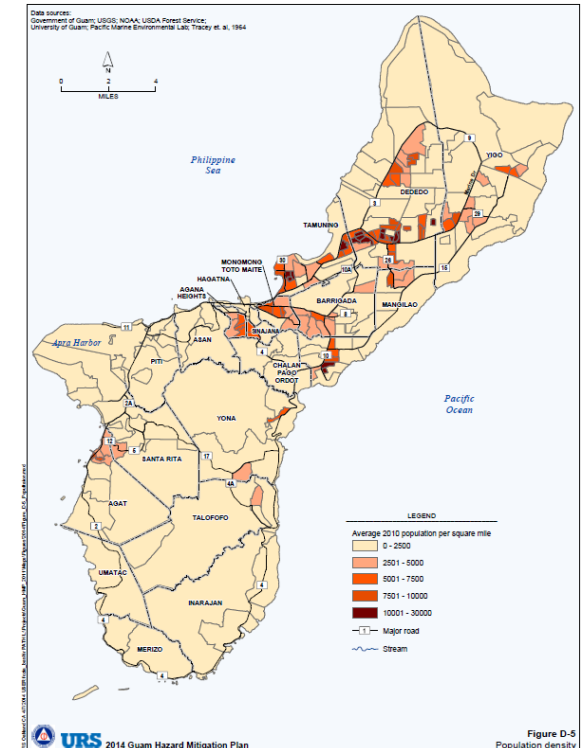
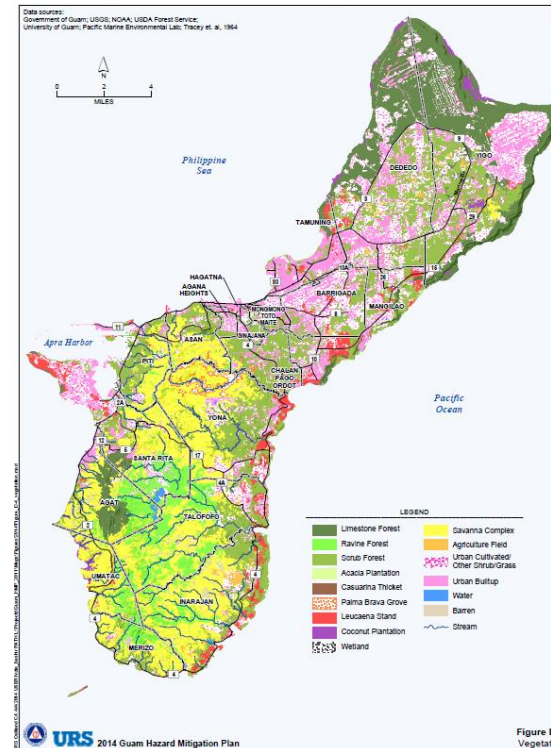
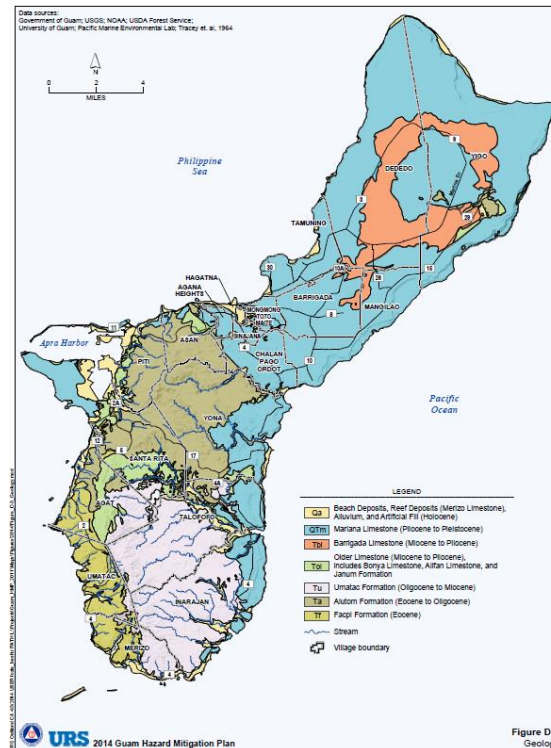
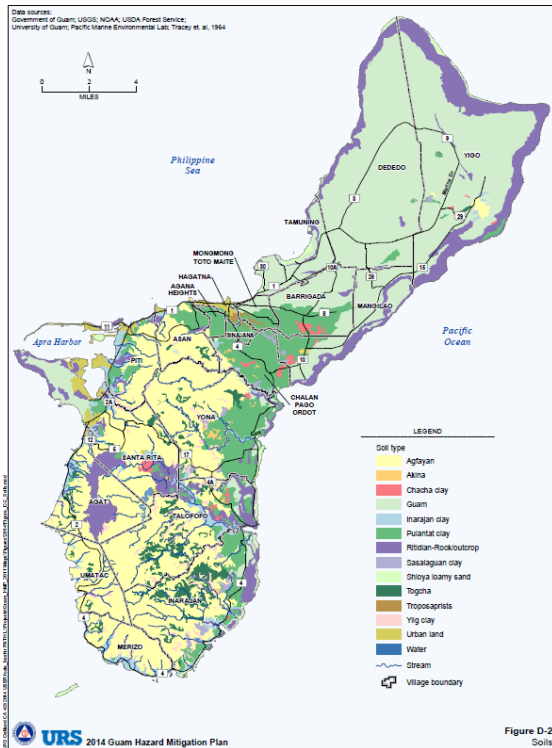
State Hazard Mitigation Plan

- Approved: 24 July 2014
- The 2014 Guam HMP is authorized by the Guam Civil Defense Act of 1951, as amended by Public Law 24-298 (included in Original Government Code of Guam enacted by Public Law 1-88, 1952), and Executive Order 97-18
- State standard plan
- Currently being updated in-house
- Attention invited on:
 - Risk Assessment
 - Mitigation Strategy*
- Challenges:
 - Data collection
 - Baselines/data update
 - GIS support



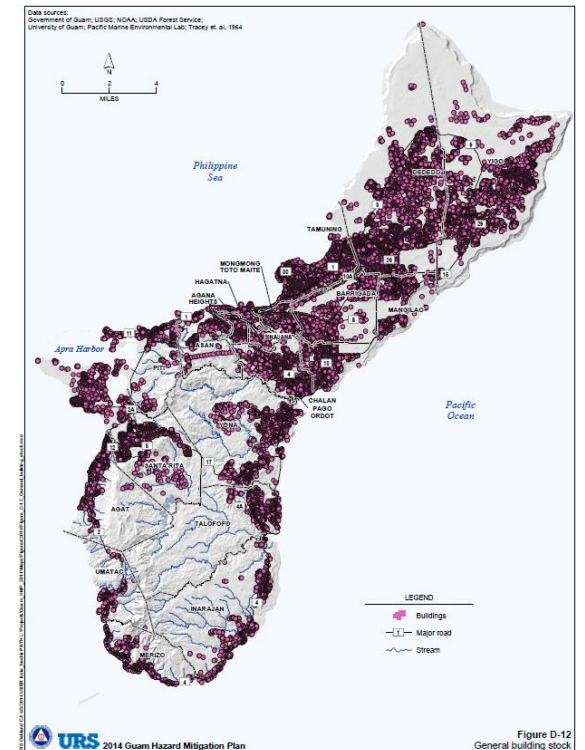
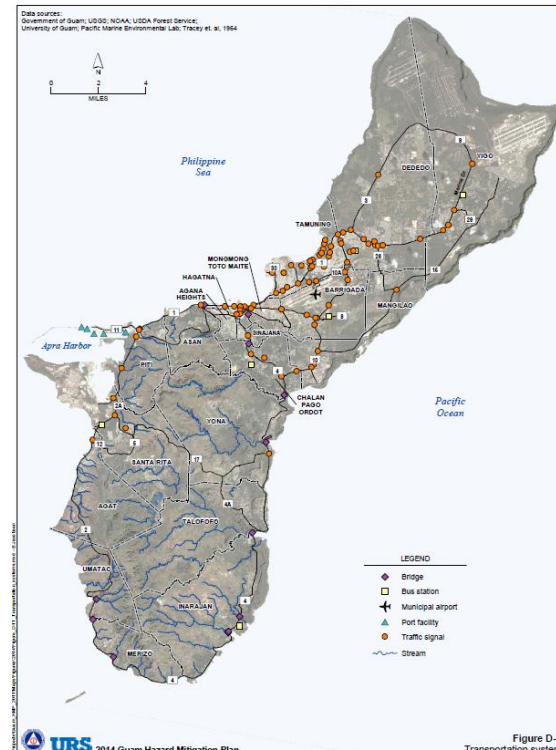
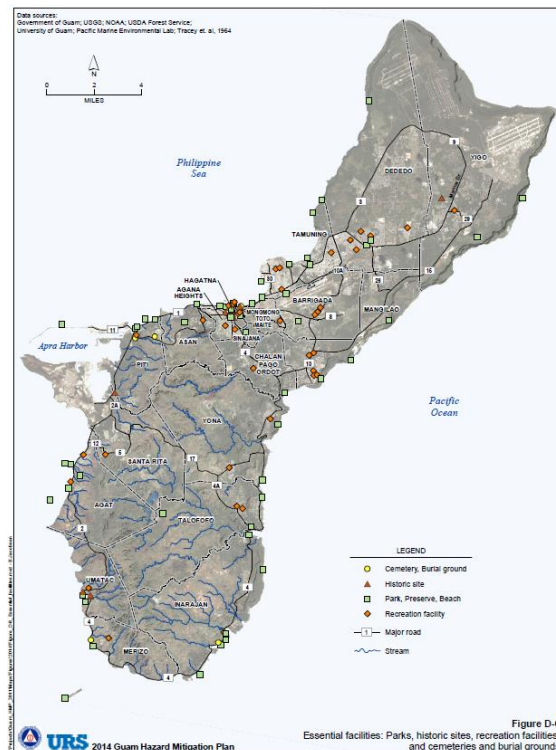
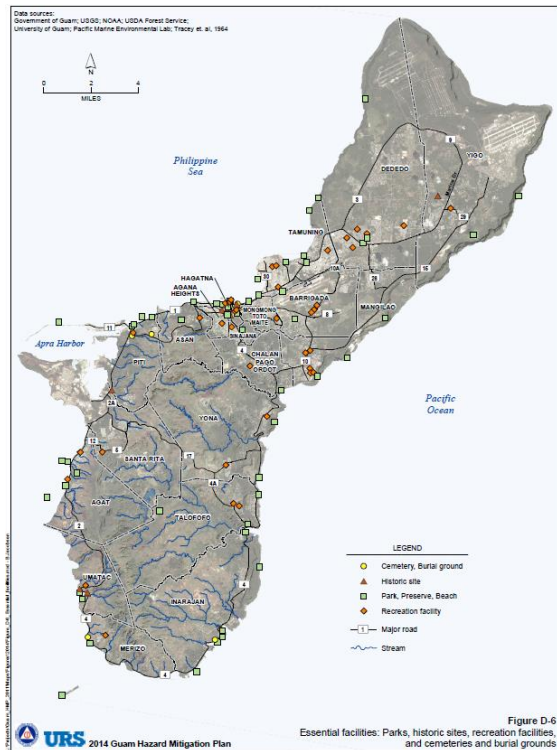
State Hazard Mitigation Plan

- Soils
- Geology
- Vegetation
- Population



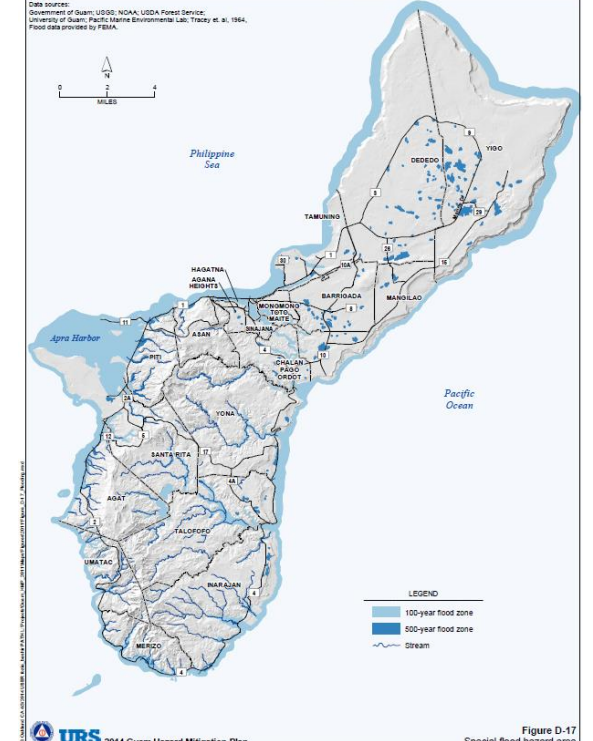
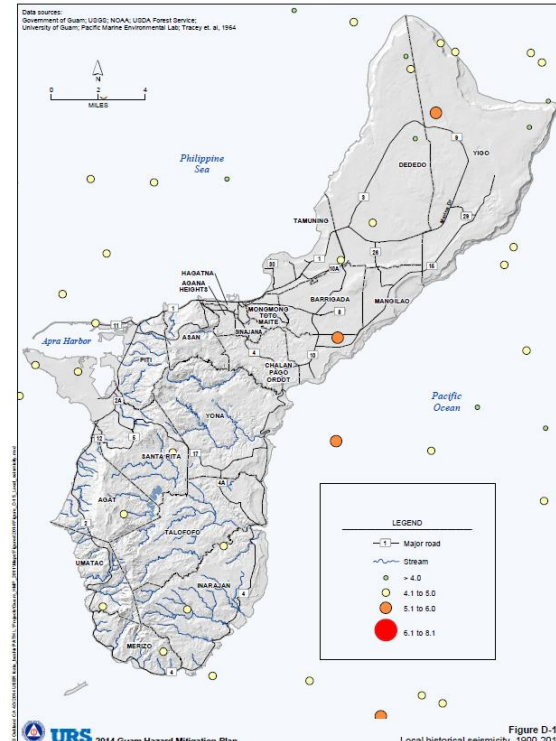
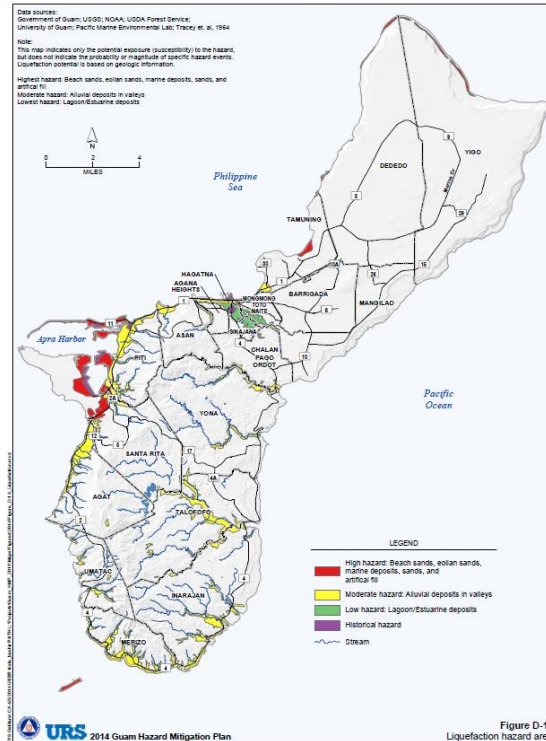
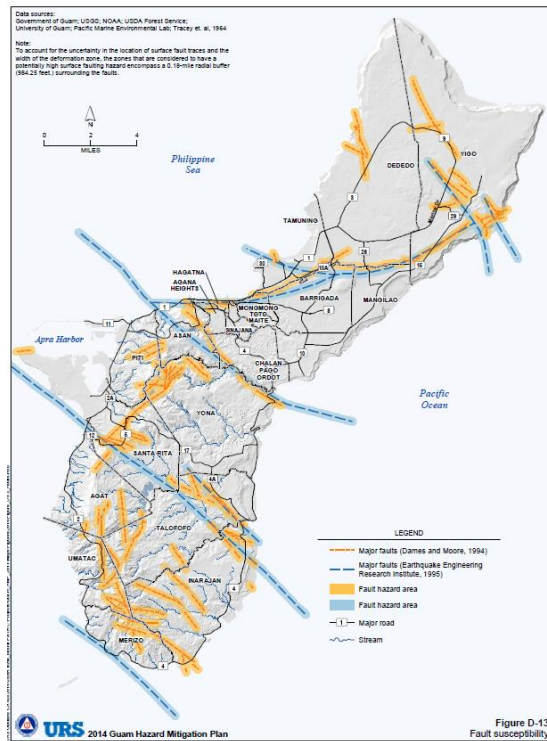
State Hazard Mitigation Plan

- Essential Facilities
- Major Utilities
- Transportation System
- General Building Stock



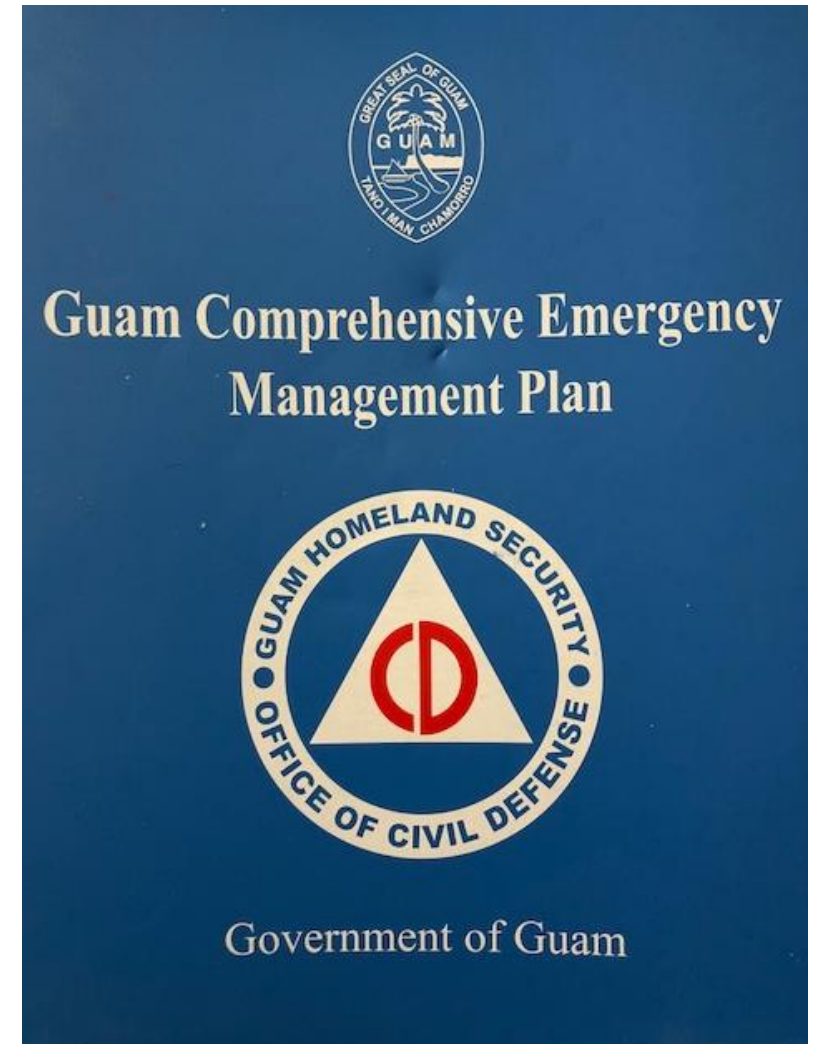
State Hazard Mitigation Plan

- Faults
- Liquefaction
- Local Seismicity
- Flooding



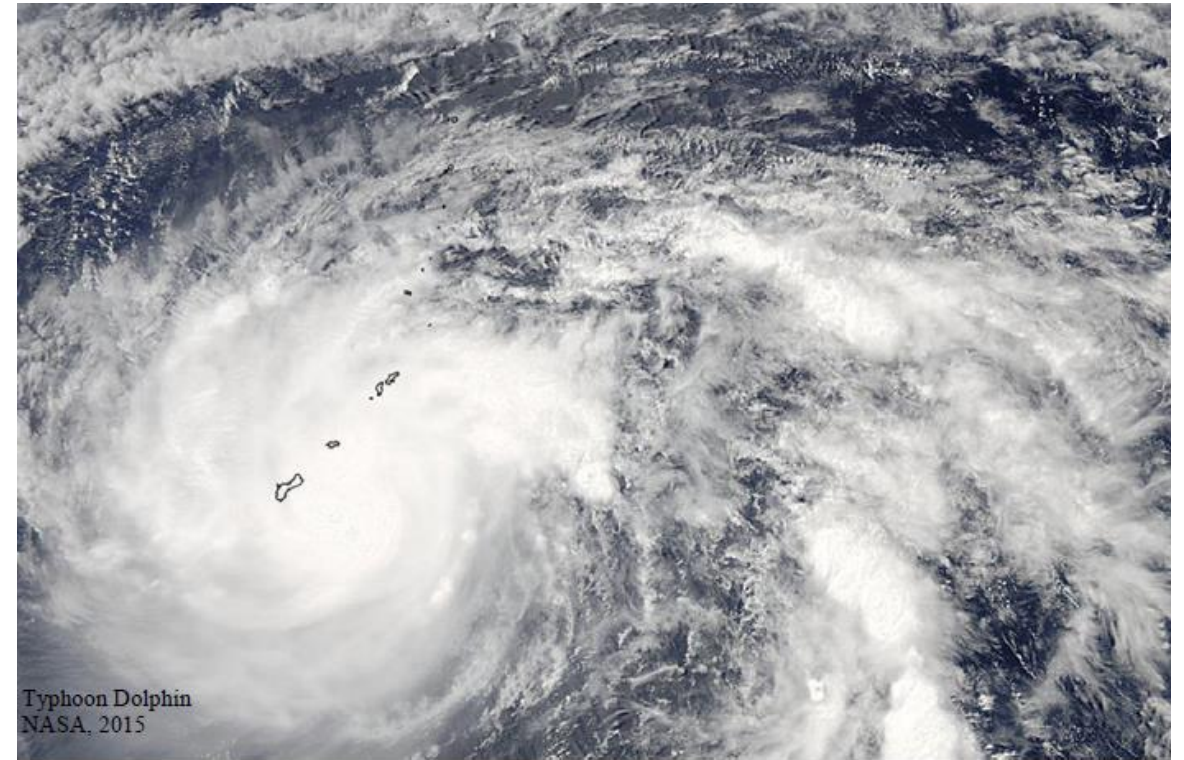
Guam Comprehensive Emergency Management Plan

- Approved: 13 Dec 2016
- Currently being updated in-house
- Pursuant to Guam Civil Defense Act of 1951, the Guam Comprehensive Emergency Management Plan (GUAM CEMP) is the master operations document for the Territory of Guam in responding to all emergencies, and all catastrophic, major, and minor disasters.
- The GUAM CEMP defines the responsibilities of all levels of government, private, volunteer and non-governmental organizations (NGOs) that make up the Guam Emergency Operations Center Emergency Support Function (EOC ESF) Team.
- The GUAM CEMP also captures the authority and role of the federal government in response to incidents and emergency events on Guam, including those which are presidentially declared disasters.
- The GUAM CEMP ensures that all levels of government are able to mobilize as a unified emergency organization to safeguard the well-being of Guam's residents and visitors.

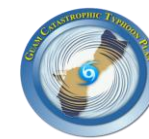


Guam Catastrophic Plan

- Jointly approved: 13 Feb 2018
- This *2018 Guam Catastrophic Typhoon Plan* is a capabilities-based document that follows National Incident Management System (NIMS)/Incident Command System (ICS) principles and will facilitate effective and efficient response and recovery operations in the response to a catastrophic typhoon strike on Guam.
- This plan was developed collaboratively with local, territorial, federal, nongovernmental, and private sector partners, consistent with the Whole Community doctrine.
- This plan presents actions that key Core Capability stakeholders may take to save and sustain lives and protect property of survivors impacted by a catastrophic typhoon on Guam.

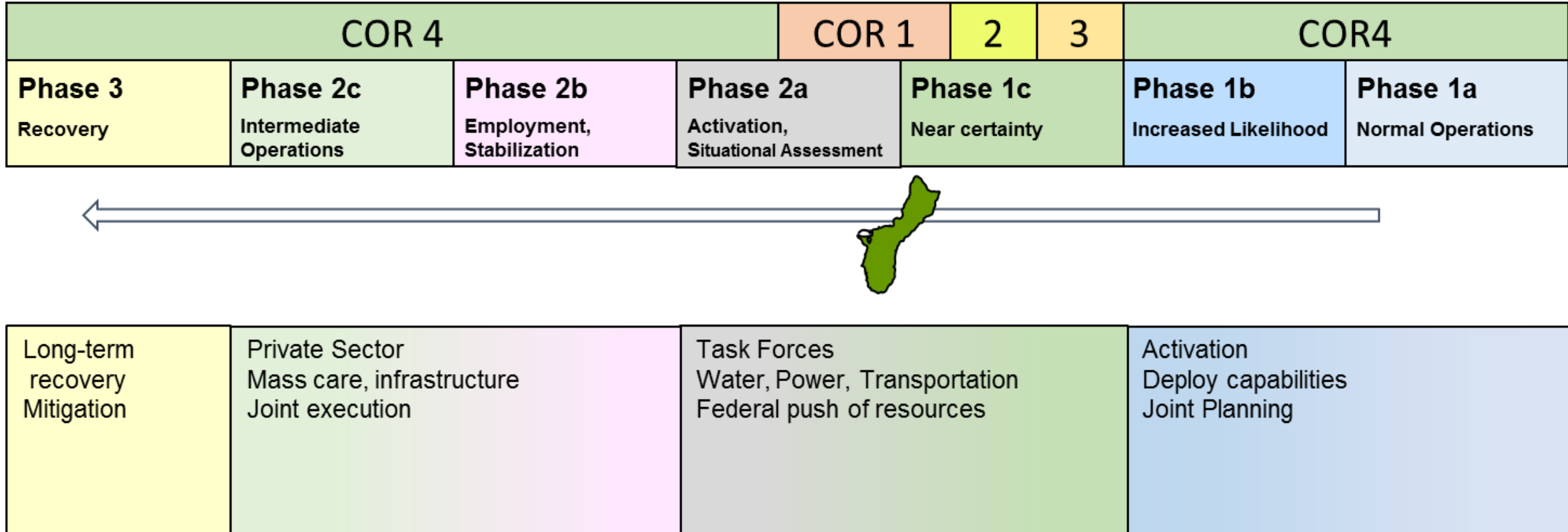


2018 Guam Catastrophic Typhoon Plan



FEMA

Concept of Operations – Time Phased



FEMA

Phase 1b

Saipan International

Tinian Airport

Rota Airport

Operations
Center

Andersen AFB

A. B. Won Pat International

Guam DC

Hawaii

Hawaii DC

Hickam AFB

FEMA Staging Area
Management Team

Travis AFB

RRCC

Region IX IMAT
• ESF Support

Moffett DC

Phase 1b: 5 days prior to anticipated landfall

- Activations (RRCC, IMAT+)
 - ESF 8
 - ESF 3 power coordination team
- Development of logistics capability
 - Facilities (DC, ISB, Staging)
 - Staging Management Teams
 - Transportation capability
- Identify 1c push requirements



FEMA

Phase 1c

Saipan International

Task Forces:

- Form TF organization in Operations Section
- Develop planning cycle
- Identify capabilities
- Identify potential requirements

Hawaii

Hawaii DC

Hickam AFB
APOD

Rota Airport

Phase 1c Prepared to push
resources from Hawaii DC

Push TF staff and
capabilities

Operations
Center

Joint Organization

Andersen AFB

Guam DC

A. B. Won Pat International

FSA

Travis AFB

ISB

Transportation
Capability

RRCC

Mobilization
Support Facility

Moffett DC

Phase 1c: 48 hours prior to landfall

- RSOI – Mobilization Support Operations
- Activate transportation capabilities (Air, Ground)
- Form the UCG
- Form Task Forces in Operations Section
- Push package (1c)
 - USACE Power PRT, 249th Prime Power, Advanced Contracting Initiative capabilities
 - NDMS
- Identify and activate resource capability (TF)
- Pre-landfall assessments



FEMA

Phase 2a

Task Forces:

- Conduct post landfall assessments
- Develop response concepts
- Build capability (MAs, contracts, activations)

Joint Organization

IOF

Guam DC

FSA

Andersen AFB

A. B. Won Pat International

Hawaii

Hawaii DC

Hickam AFB
APOD

Pull resources as required
from HI and CONUS

TF staff and capabilities as
required

Phase 2a: Post-landfall

- Continue RSOI function
- Transition movement coordination to a pull system
- Support assessments and build capability

Travis AFB

ISB

RRCC

Mobilization
Support Facility

Moffett DC

Transportation
Capability



FEMA

Phase 2b

Task Forces:

- Build capability
- Execute (direct) operations
- Maintain a continuous assessment
- Maintain planning cycle

Joint Organization

IOF

Guam DC

FSA

Andersen AFB

A. B. Won Pat International

Hawaii

Hawaii DC

Hickam AFB
APOD

Pull resources as required
from HI and CONUS

TF staff and capabilities as
required

Phase 2b: Post-landfall

- Continue RSOI functions
- Transition movement coordination to a pull system
- Support assessment and build capability

Travis AFB

ISB

RRCC

Mobilization
Support Facility

Moffett DC

Transportation
Capability



FEMA

Phase 2c

Task Forces:

- Execute (direct) operations
- Maintain a continuous assessment
- Maintain planning cycle

Joint Organization

JFO

Guam DC

FSA

Andersen AFB

A. B. Won Pat International

Hawaii

Hawaii DC

Hickam AFB
APOD

Pull resources as required
from HI and CONUS

TF staff and capabilities as
required

Shift focus of the operation to
the field

Travis AFB

ISB

RRCC

Mobilization
Support Facility

Moffett DC

Phase 2c: Post-landfall

- Phase out RSOI functions
- Transition operational control and movement coordination to field



FEMA

Typhoon “Pakyo” Exercise

Tabletop Exercise

- Date: 2nd Week of June 2019

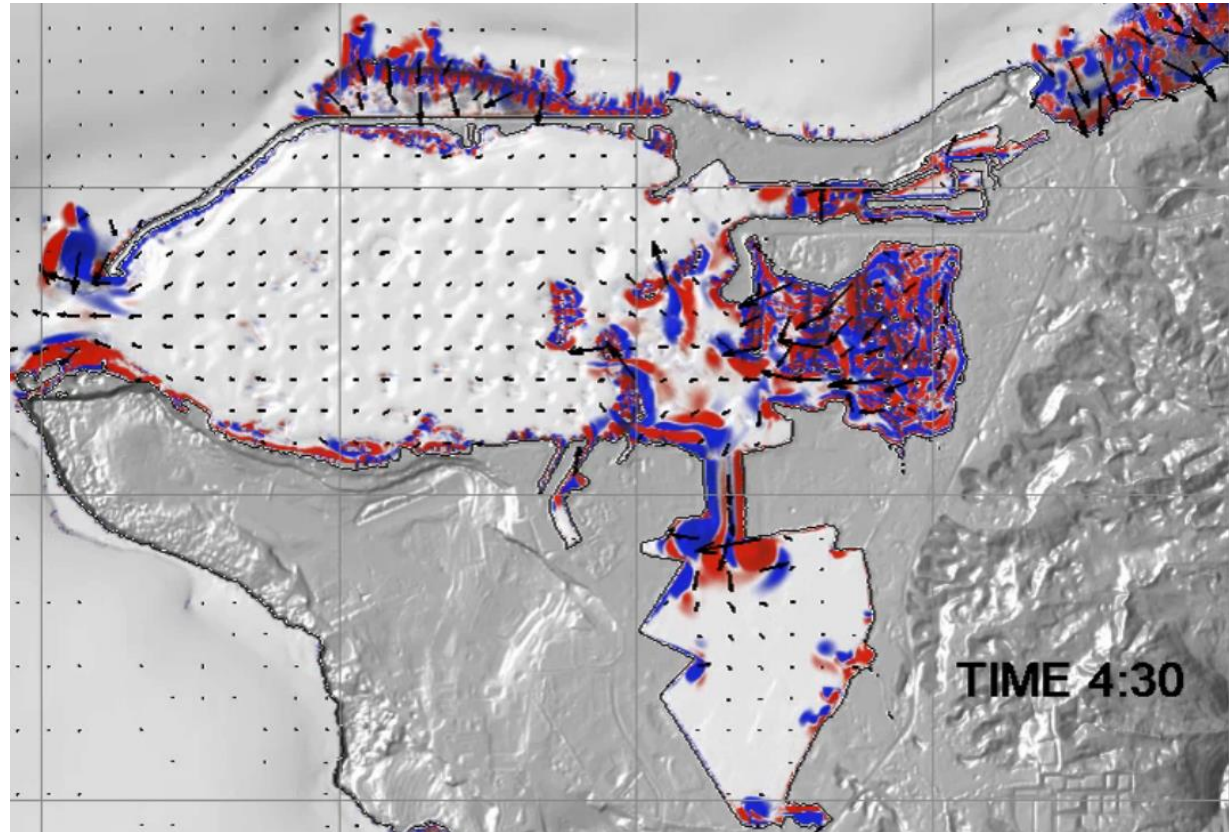
Full Scale Exercise

- Date: 2nd Week of June 2020

Pacific Wave Exercise

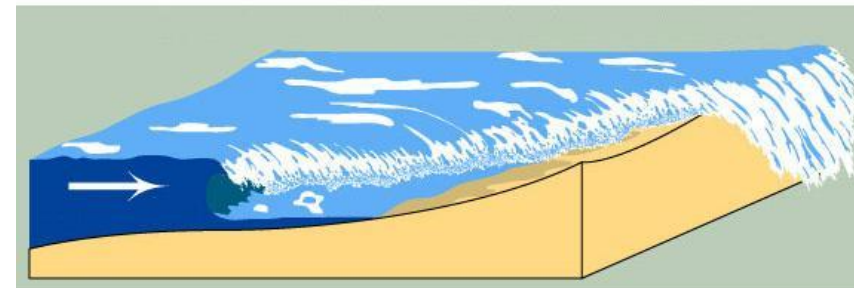
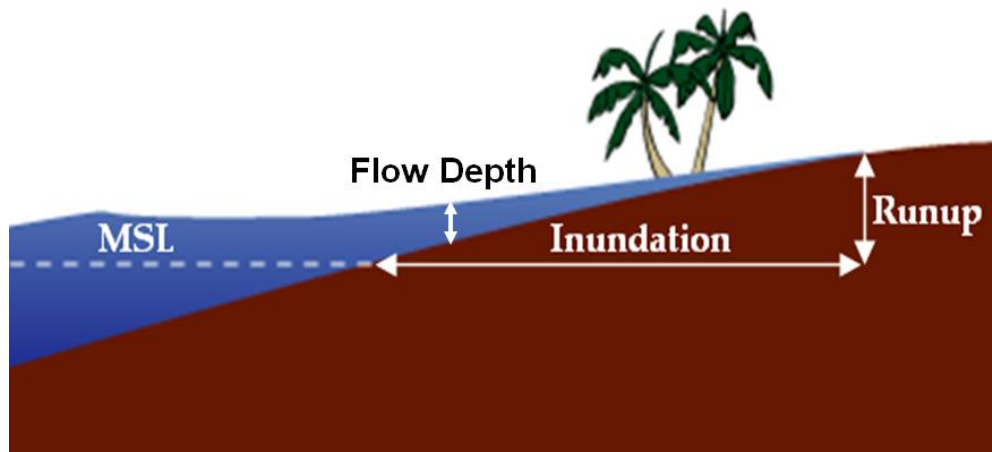
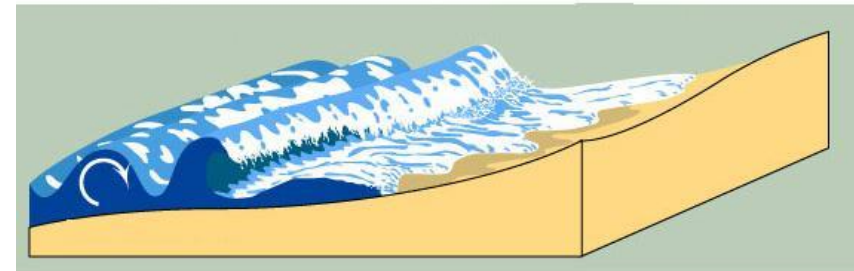
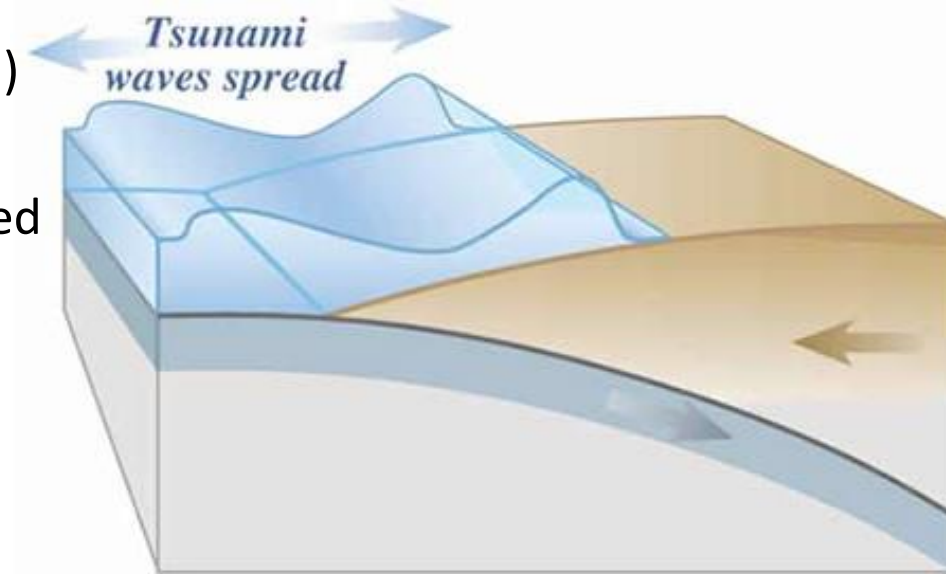
- Date: TBA

NeoWave Tsunami Modeling for Apra Harbor, Guam



Basic Concepts and Terminology

- Distant (far-field) versus local (near-field) tsunamis
- Wave speed up to 950 km/hr (wave speed \neq flow speed)
- Different flow characteristics from wind waves or swell
- 3D physical problems
- 2D mathematical models with pre-defined flow patterns over water column
- Inundation versus flow depth & runup



Community Input and Participation

Site visits and stakeholder meetings to define data products (January 16 – 18, 2018)

USCG Sector Guam

- Potential use of advisory-level tsunami scenarios in its severe weather plan
- Potential use of extreme tsunami scenarios for evacuation guidance
- Coordination with Port Authority of Guam and Naval Base Guam in plan development

Guam Power Authority

- Utilization of extreme tsunami scenarios in impact assessment of its power plant and fuel storage as well as siting of new facilities at Apra harbor

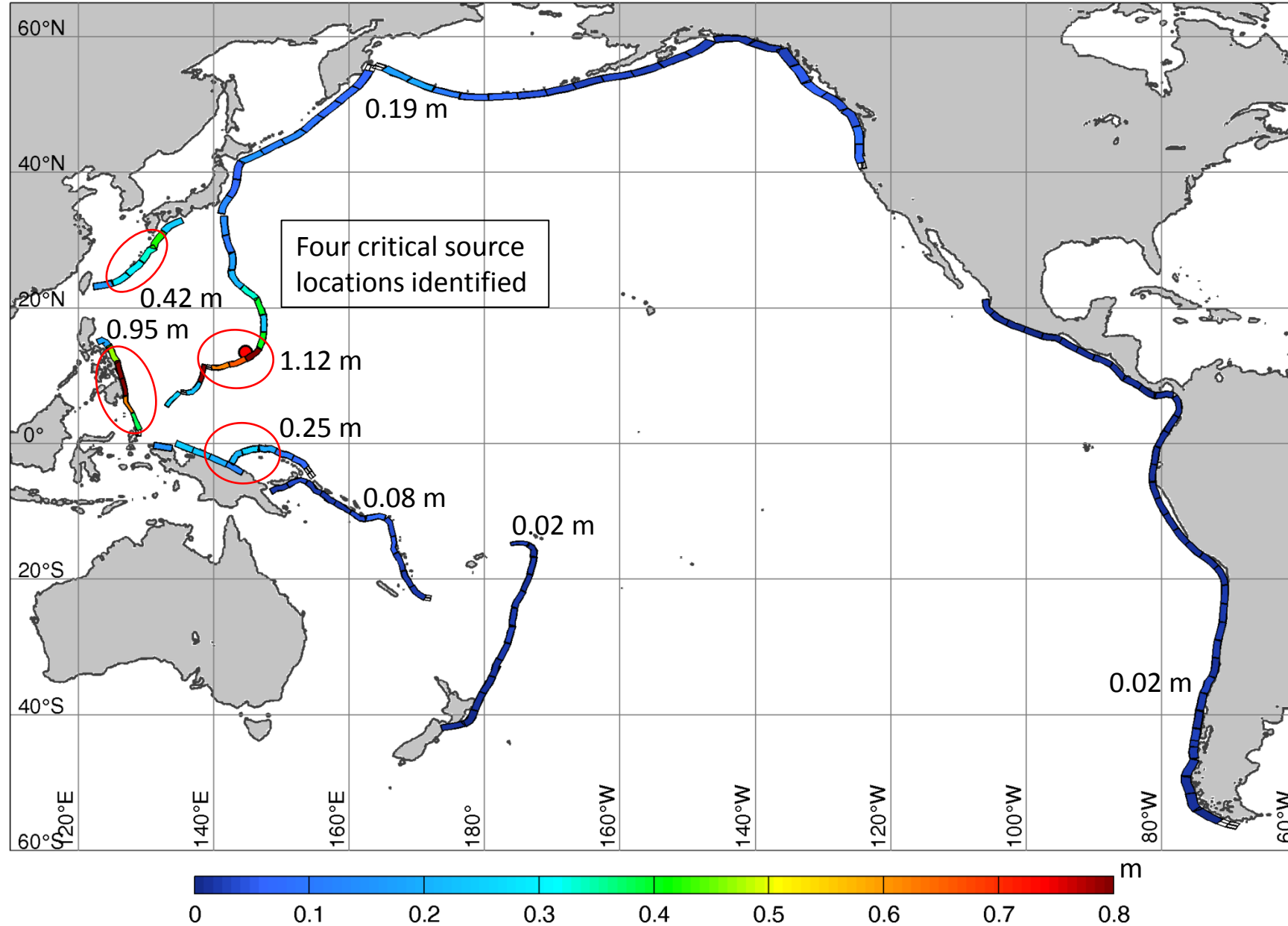
Guam Waterworks Authority

- Utilization of extreme tsunami scenarios in vulnerability assessment of its wastewater treatment plant at Agana Bay



Tsunami Surge Elevation offshore of Apra Harbor, Guam

From Mw 8.5 earthquakes at Pacific Subduction Zones



Critical Tsunami Sources for Guam

Source characteristics

- USGS and NOAA PMEL fault parameterization (Gica et al., 2008)
- Global Earthquake Model (Berryman et al., 2015)

Direction	Tsunami Source	Dip (°)	Convergence Rate (mm/yr)	Coupling Coef (Preferred)	Magnitude (Preferred max)
Local	Marianas*	22	63	0.1 – 0.7 (0.2)	7.2 – 9.5 (8.3)
North	Nankai* Ryukyu	13	50	0.8 – 1.0 (0.9)	8.5 – 8.9 (8.7)
		17	96	0.1 – 0.7 (0.2)	8.0 – 9.1 (8.5)
West	Philippine*	46	36	0.1 – 0.8 (0.3)	7.6 – 9.3 (8.5)
South	New Guinea* Manus	8	22	0.6 – 0.8 (0.7)	8.2 – 9.4 (8.8)
		15	9	0.3 – 0.7 (0.5)	7.5 – 9.5 (8.5)

*Selected for modeling

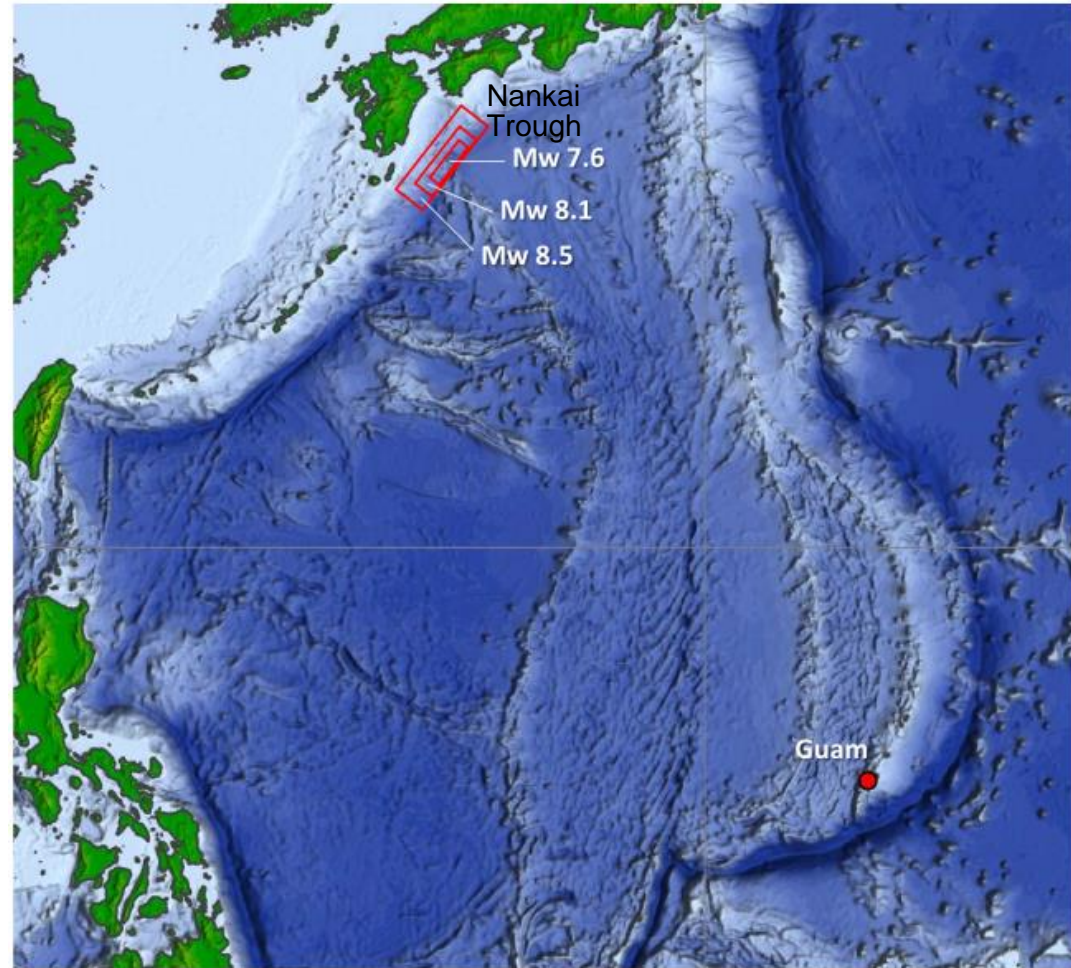
Earthquake Source Models

Tectonics

- Mw 0.1 interval up to the GEM preferred maximum magnitude
- USGS/PMEL seismic source parameters and geometry

Rupture scenarios

- Ye, Lay, Kanamori & Rivera (2016a, b, JGR Solid Earth)
- Scaling relation from Mw 7.0+ megathrust earthquakes from 1990 to 2016
- Dimensions constrained by local subduction zone



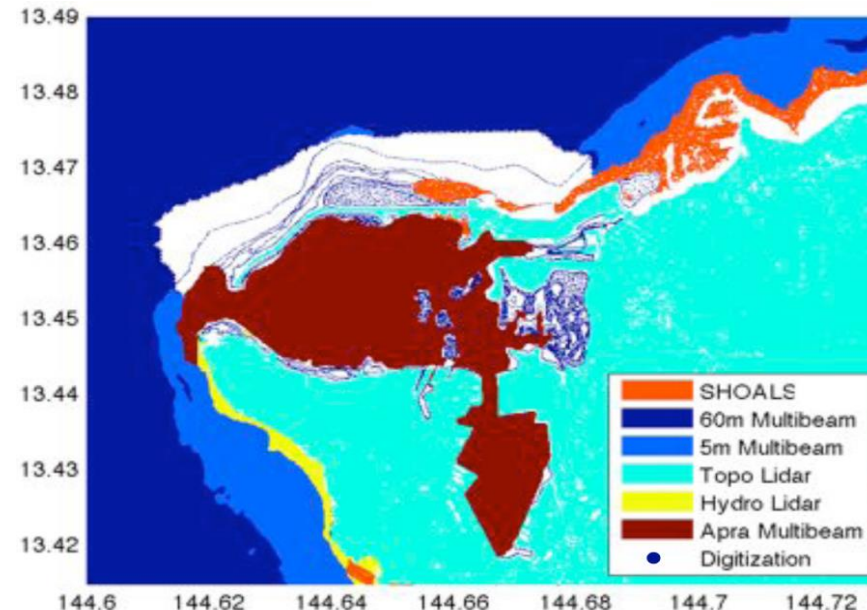
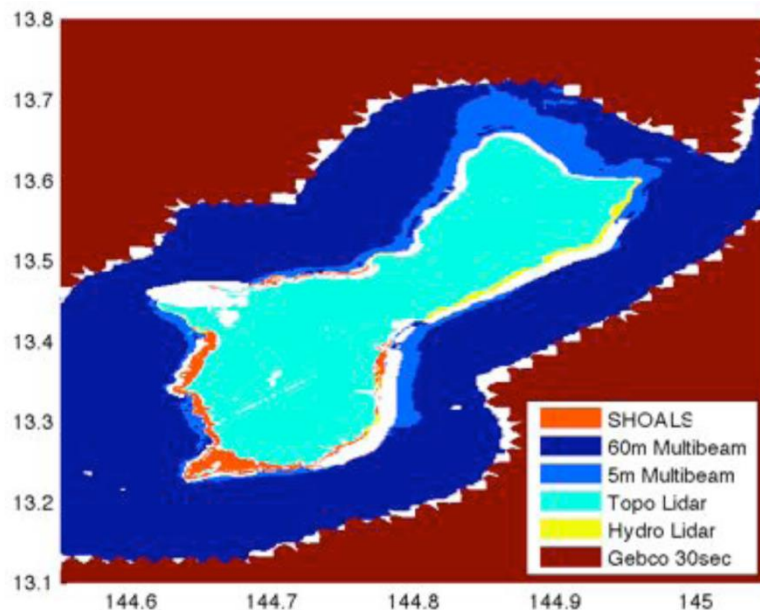
- Slip determined from seismic moment with assumed rigidity of $3 \times 10^{10} \text{ N/m}^2$

Earthquake location

- Most direct path of the tsunami to Guam

Digital Elevation Model – Data Sources

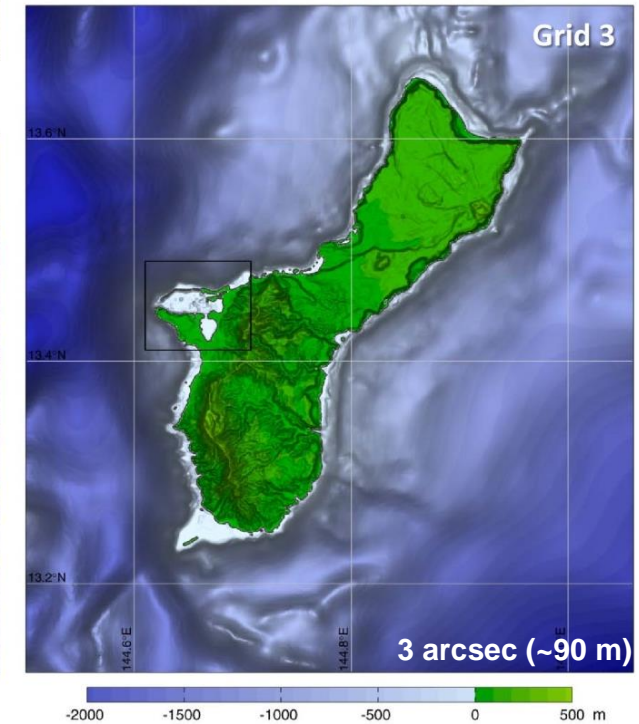
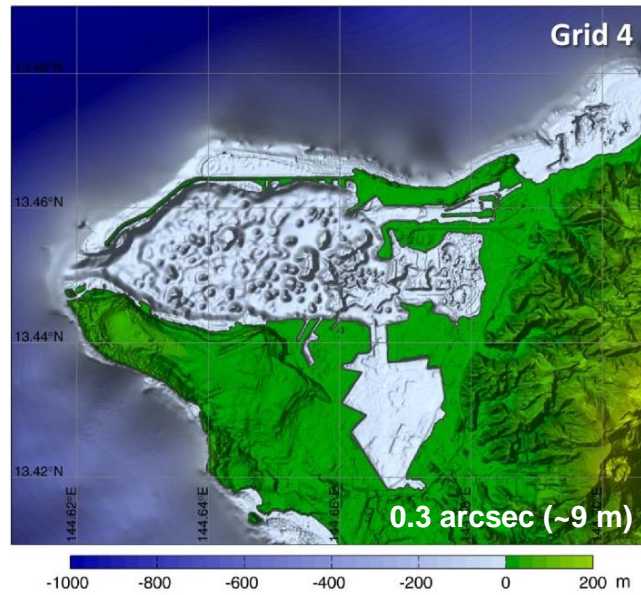
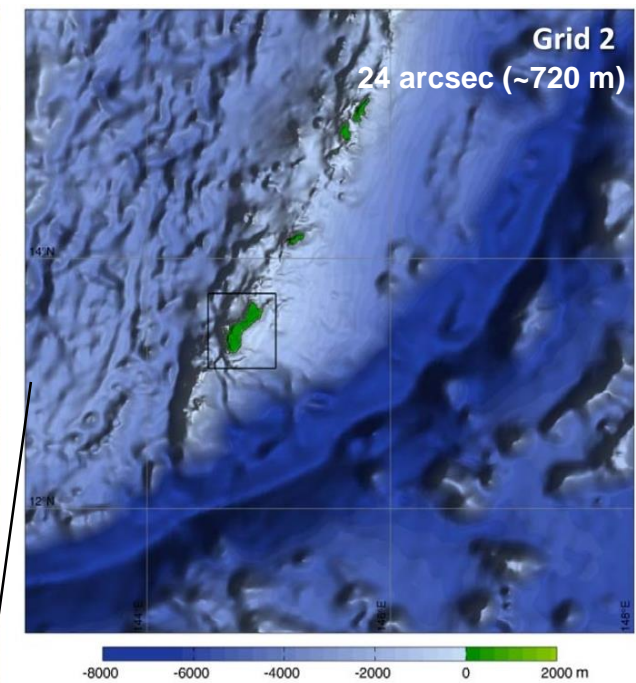
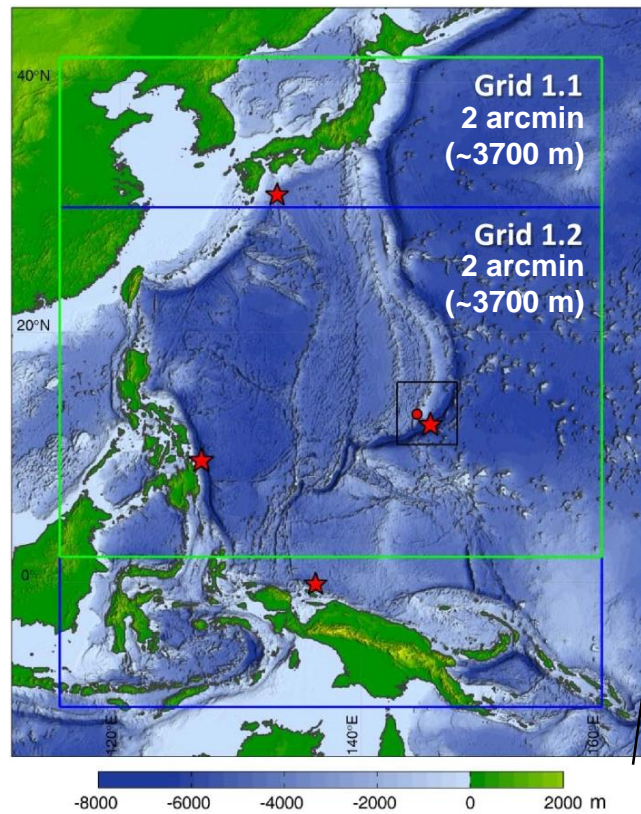
Year	Dataset	Resolution	Coverage	Source
2009	GEBCO	0.5 min	Global	BODC
2003	Multi-beam bathymetry	60 m	Guam (~3.5 km depth)	UH SOEST
2007	Multi-beam bathymetry	5 m	Guam (~400 m depth)	UH SOEST
2008	Multi-beam bathymetry	1 m	Apra Harbor	NOAA PSC
2001	SHOALS bathymetry	3~4 m	Guam (~40 m depth)	USACE
2007	LiDAR bathymetry	4 m	Guam (~40 m depth)	NOAA PSC
2007	LiDAR topography	0.5 m	Guam	NOAA PSC
-	Chart Nos. 4196, 4197	-	Apra Harbor & Vicinity	NOAA
2018	Site Visit	-	Apra Harbor & Vicinity	-



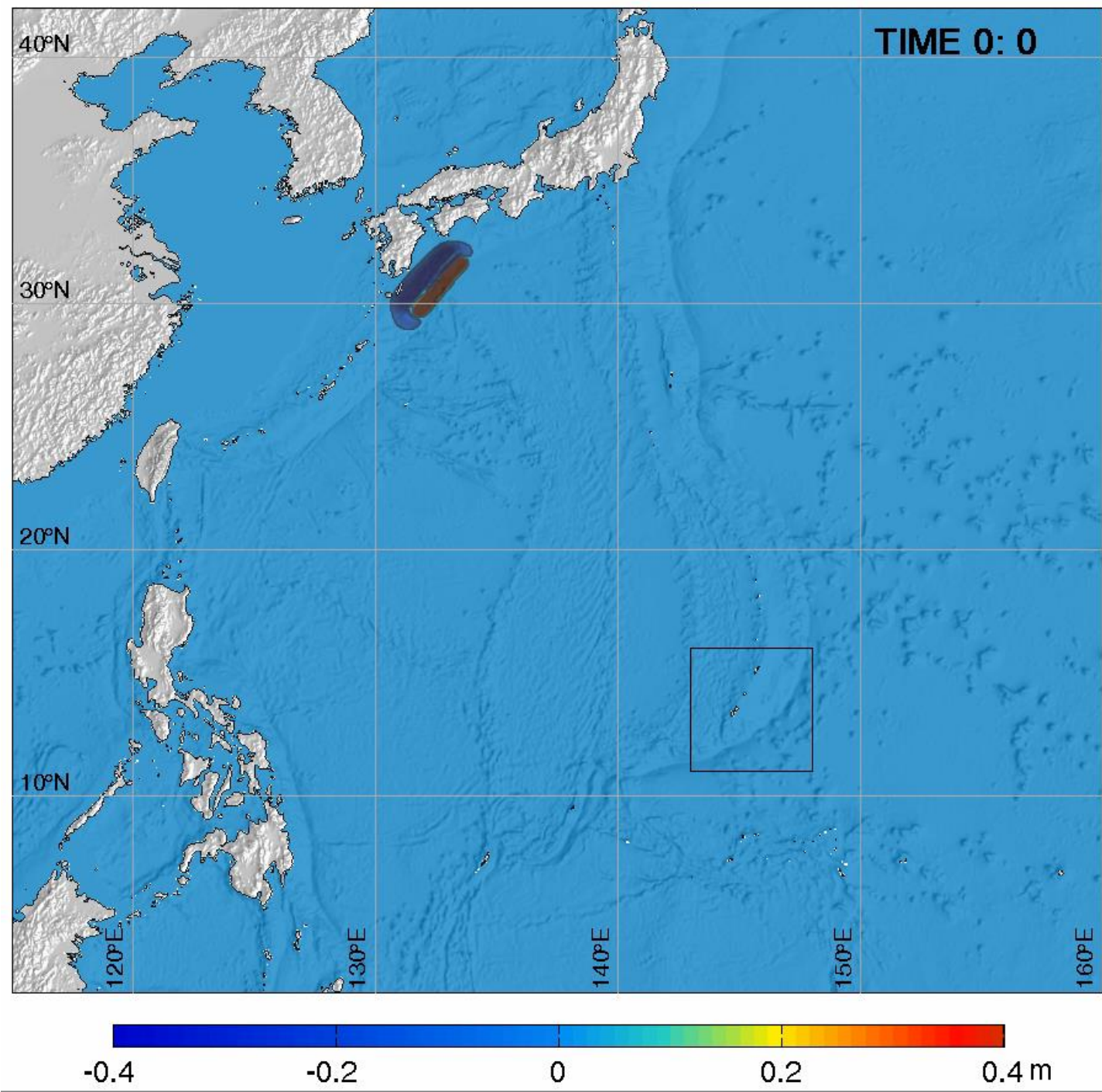
Computational Grids

Nested grid systems

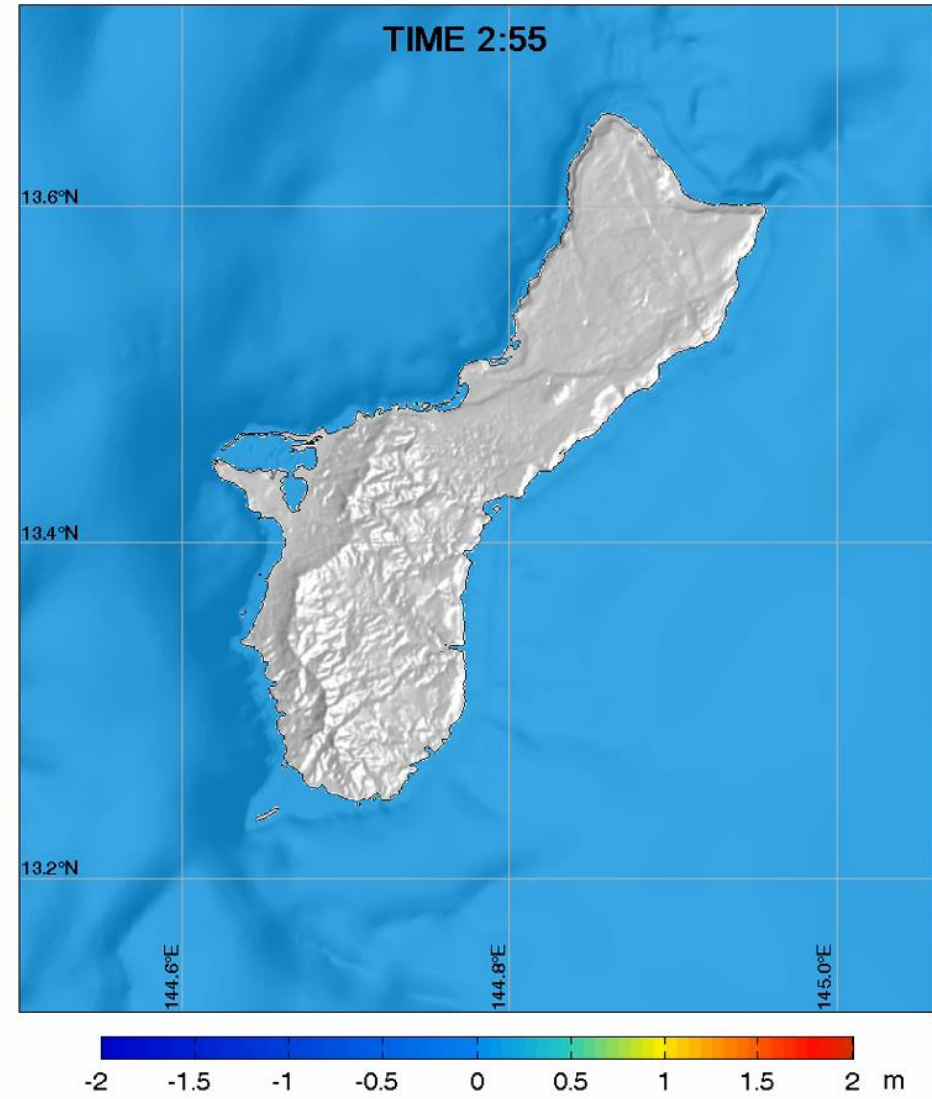
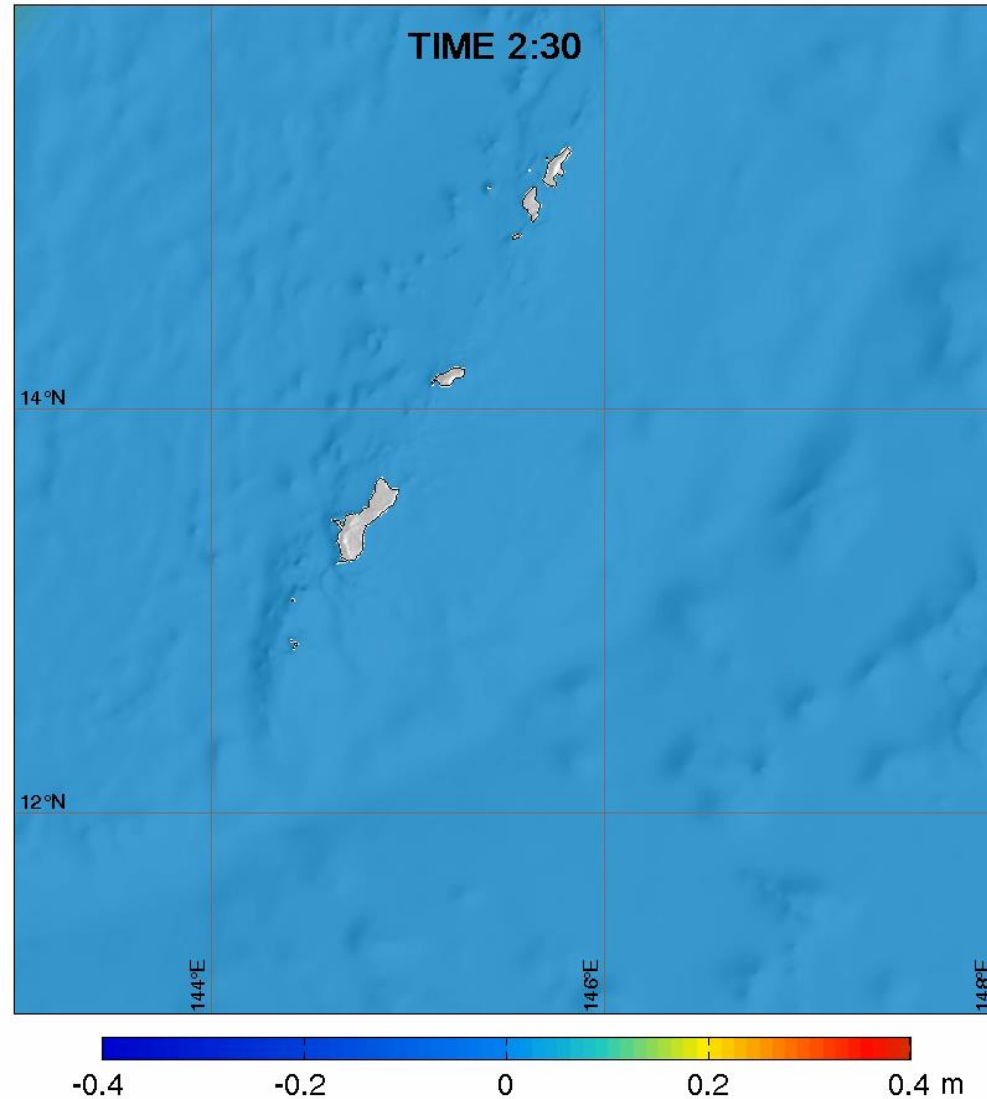
- Four levels of two-way nested grids
- Telescoping from the tsunami sources to Apra Harbor
- Removal of pile supported piers and docks from terrain model



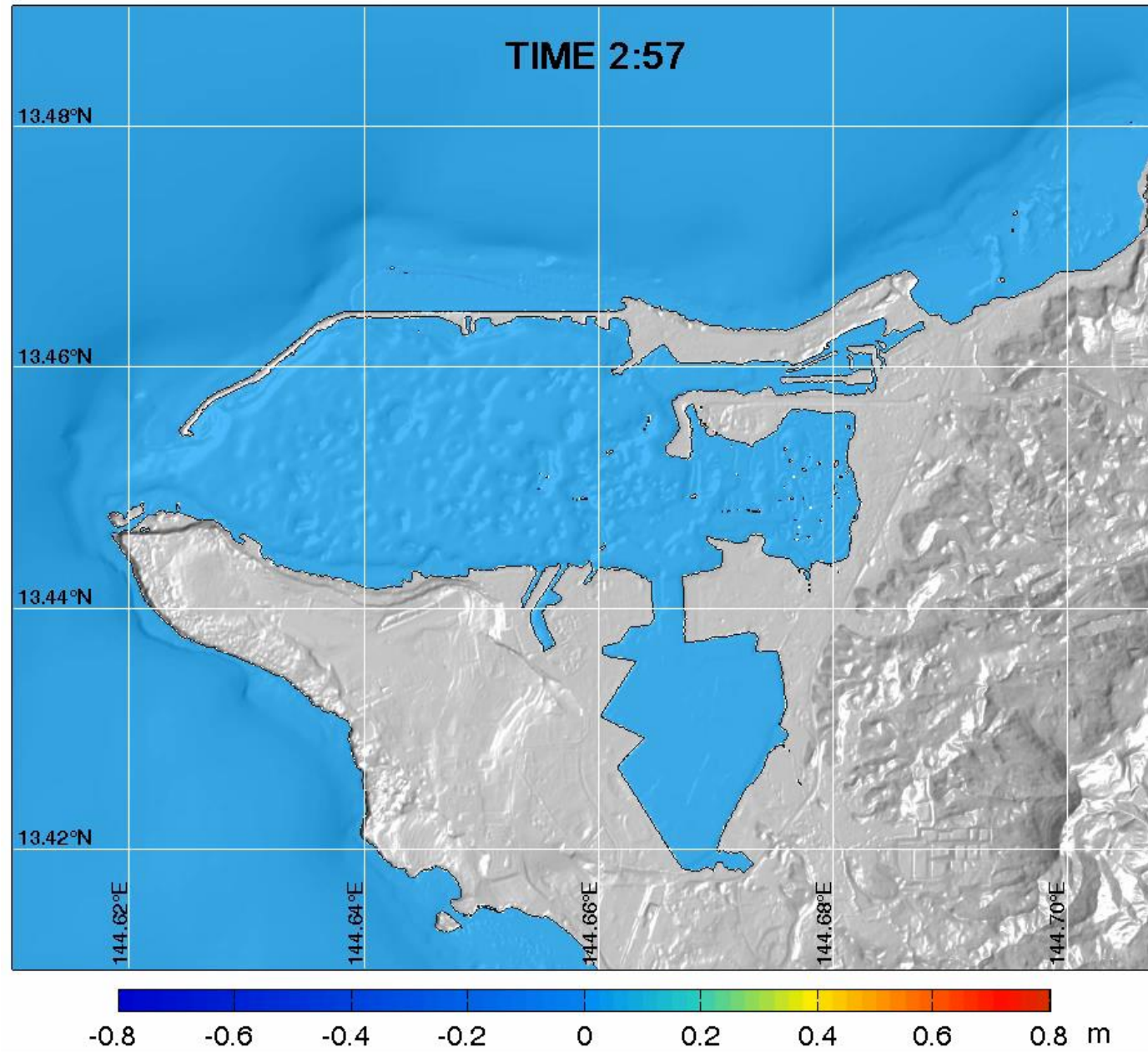
Mw 8.5 Nankai Earthquake Scenario



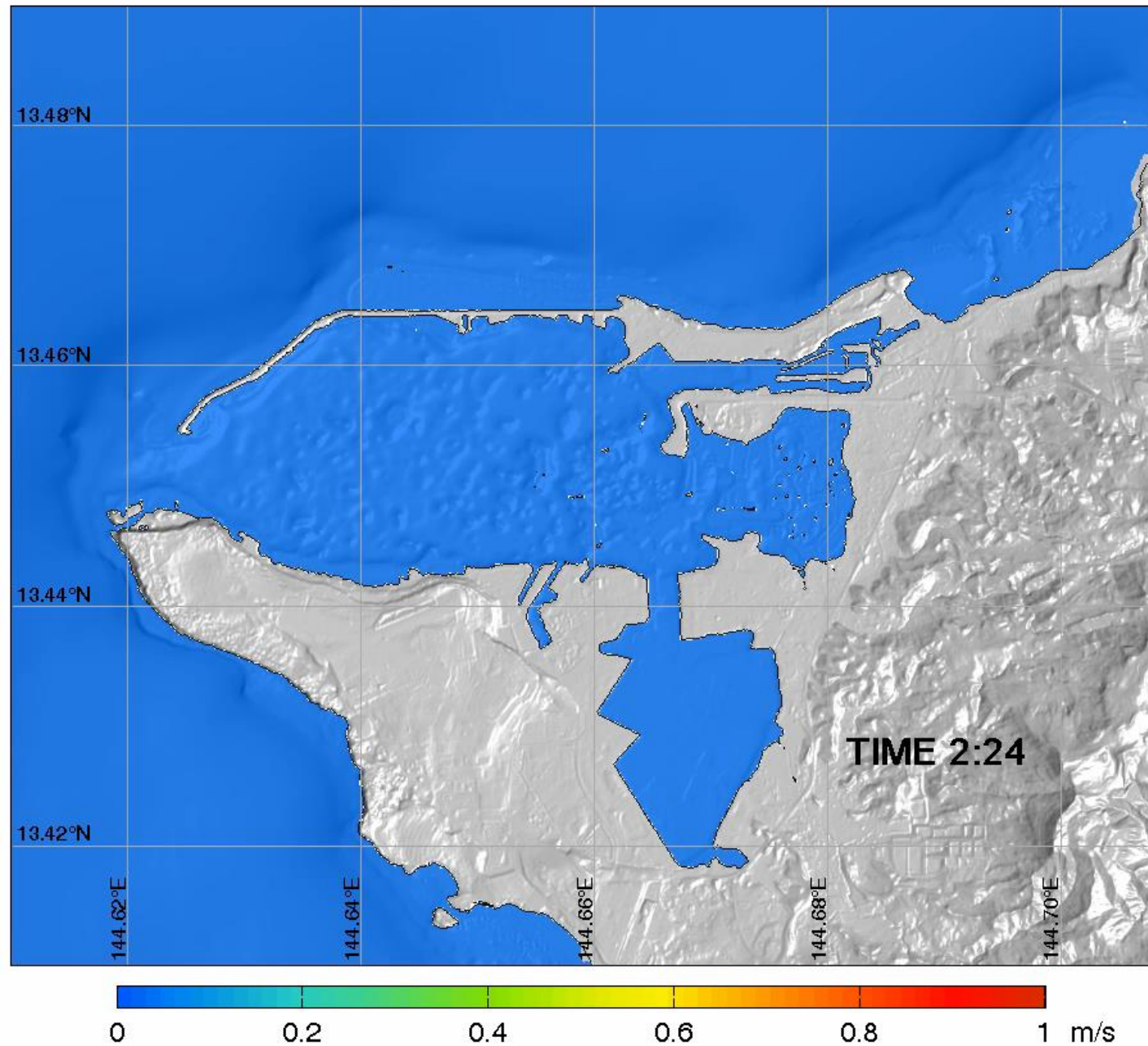
Mw 8.5 Nankai Earthquake Scenario



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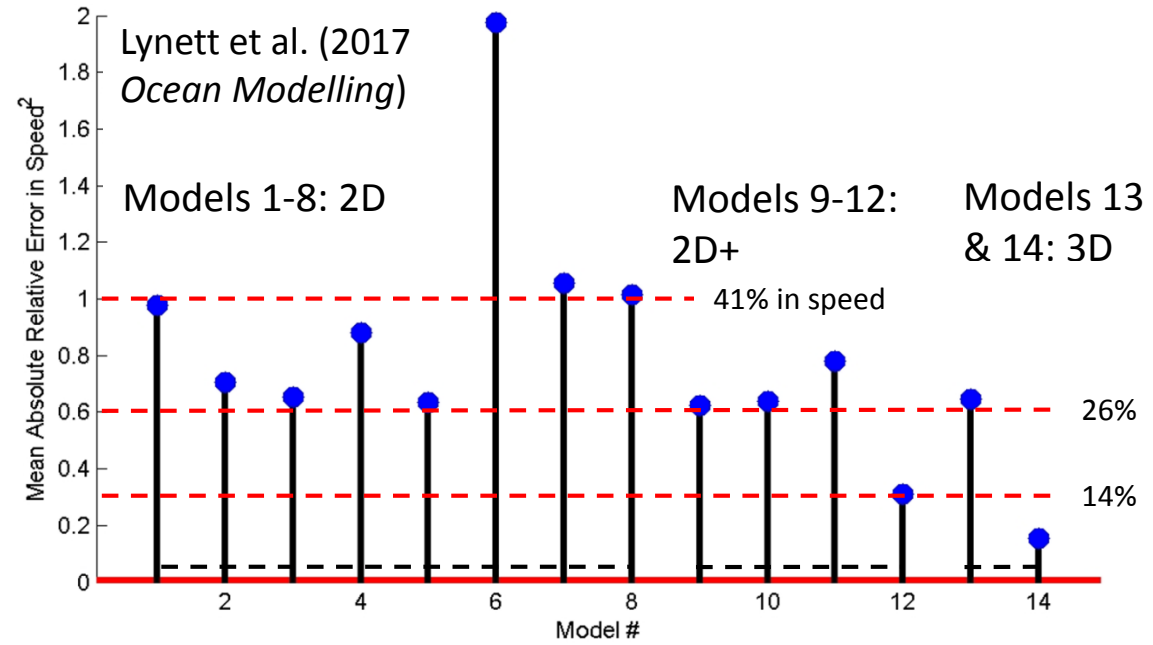
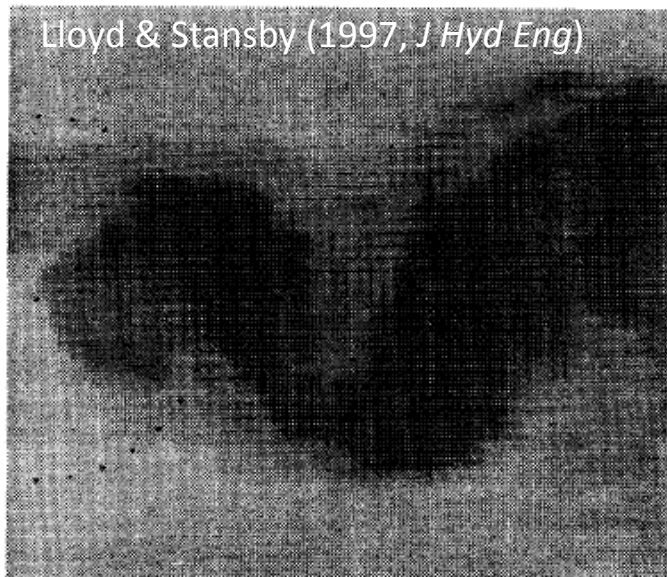
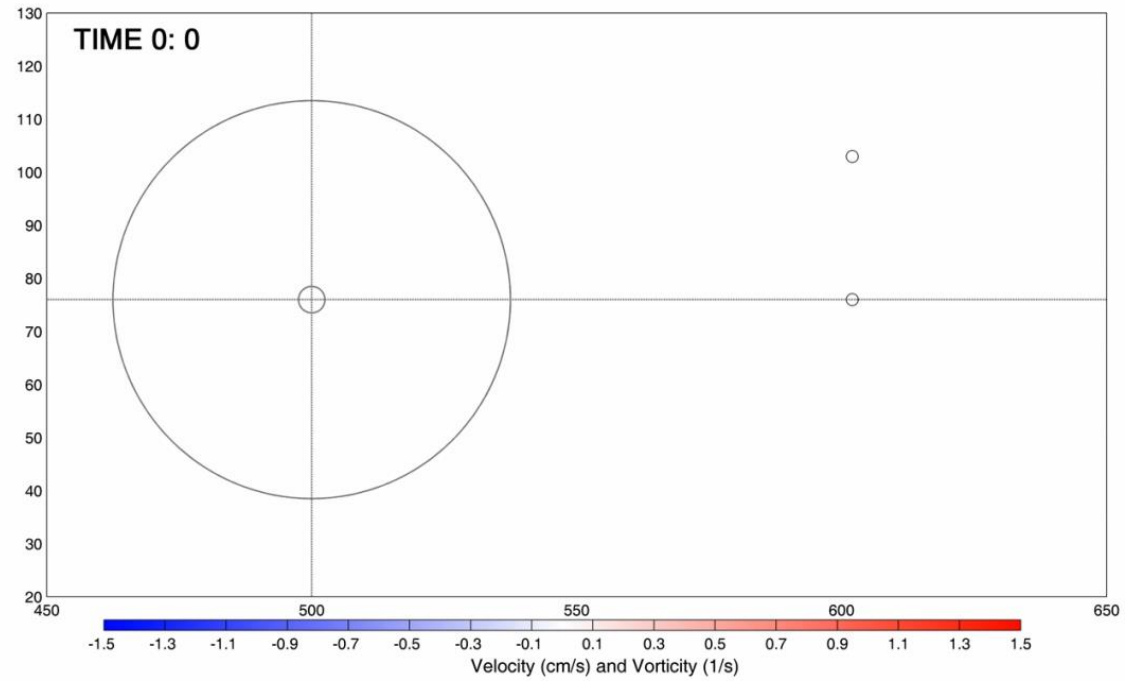
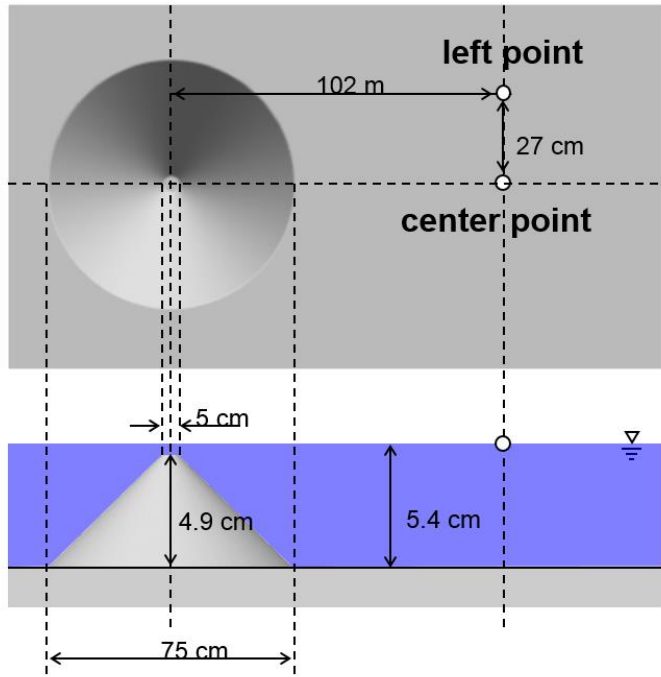
Mw 8.5 Nankai Earthquake Scenario



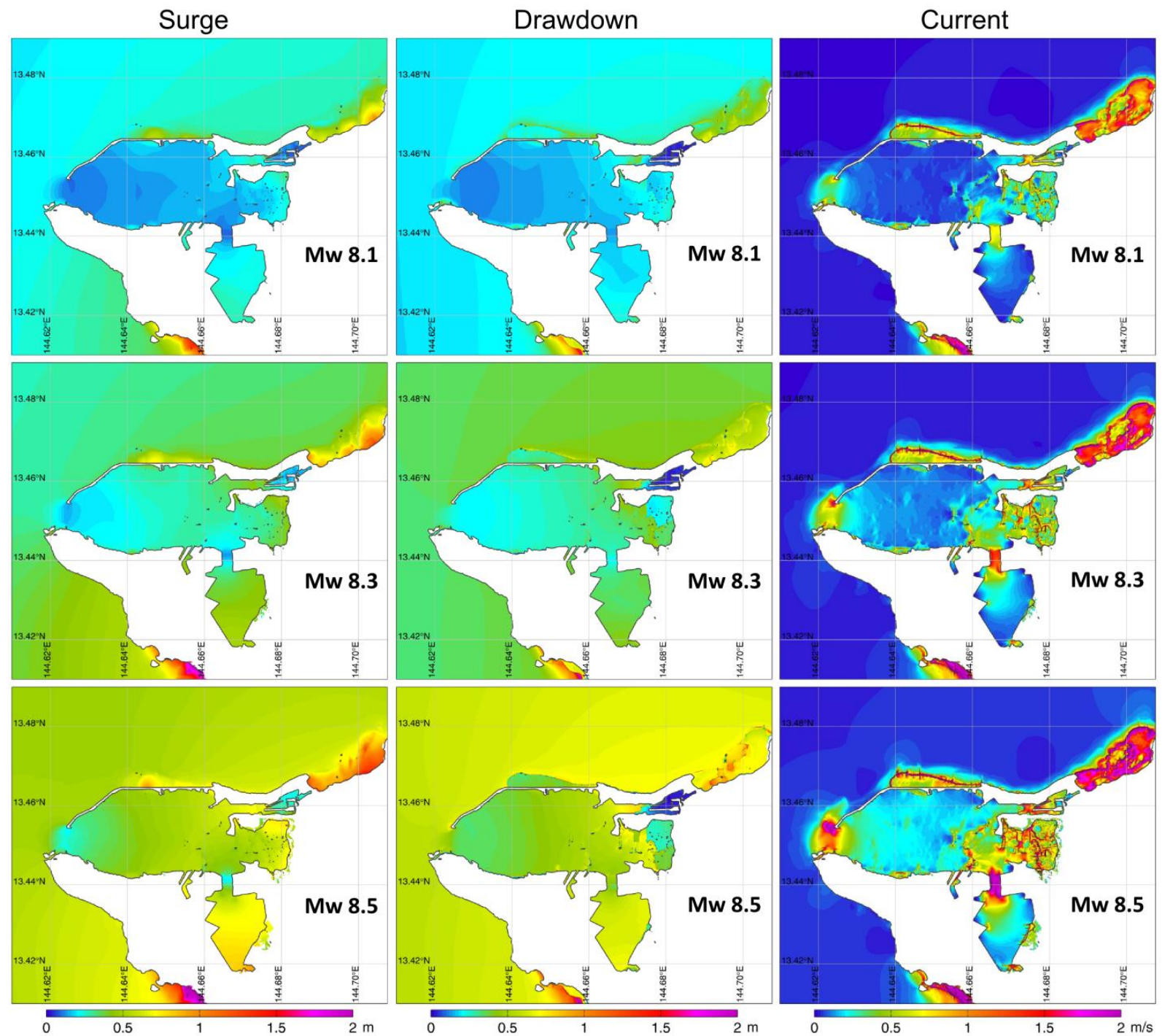
Mw 8.5 Nankai Earthquake Scenario



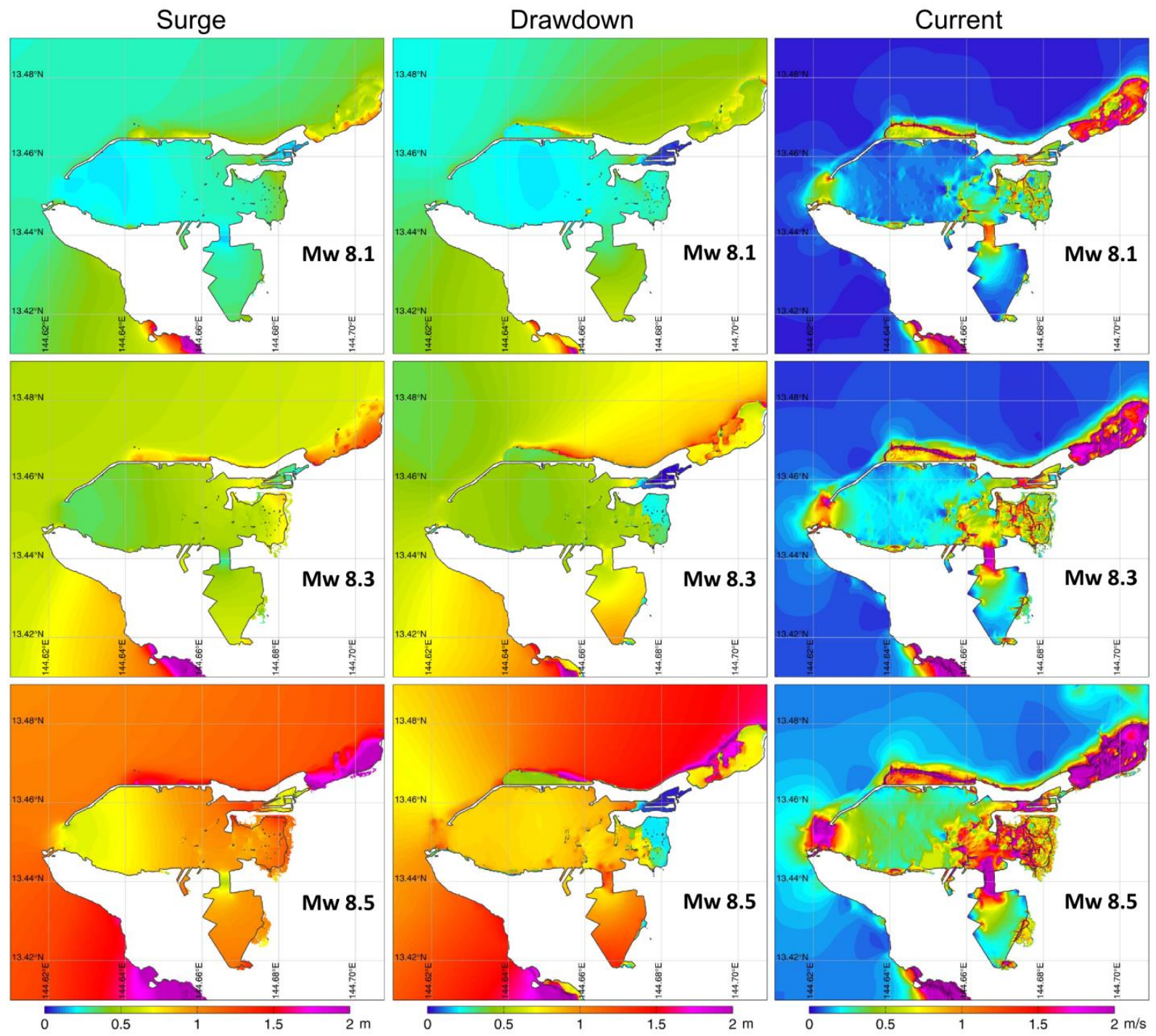
2015 NTHMP Benchmark Results



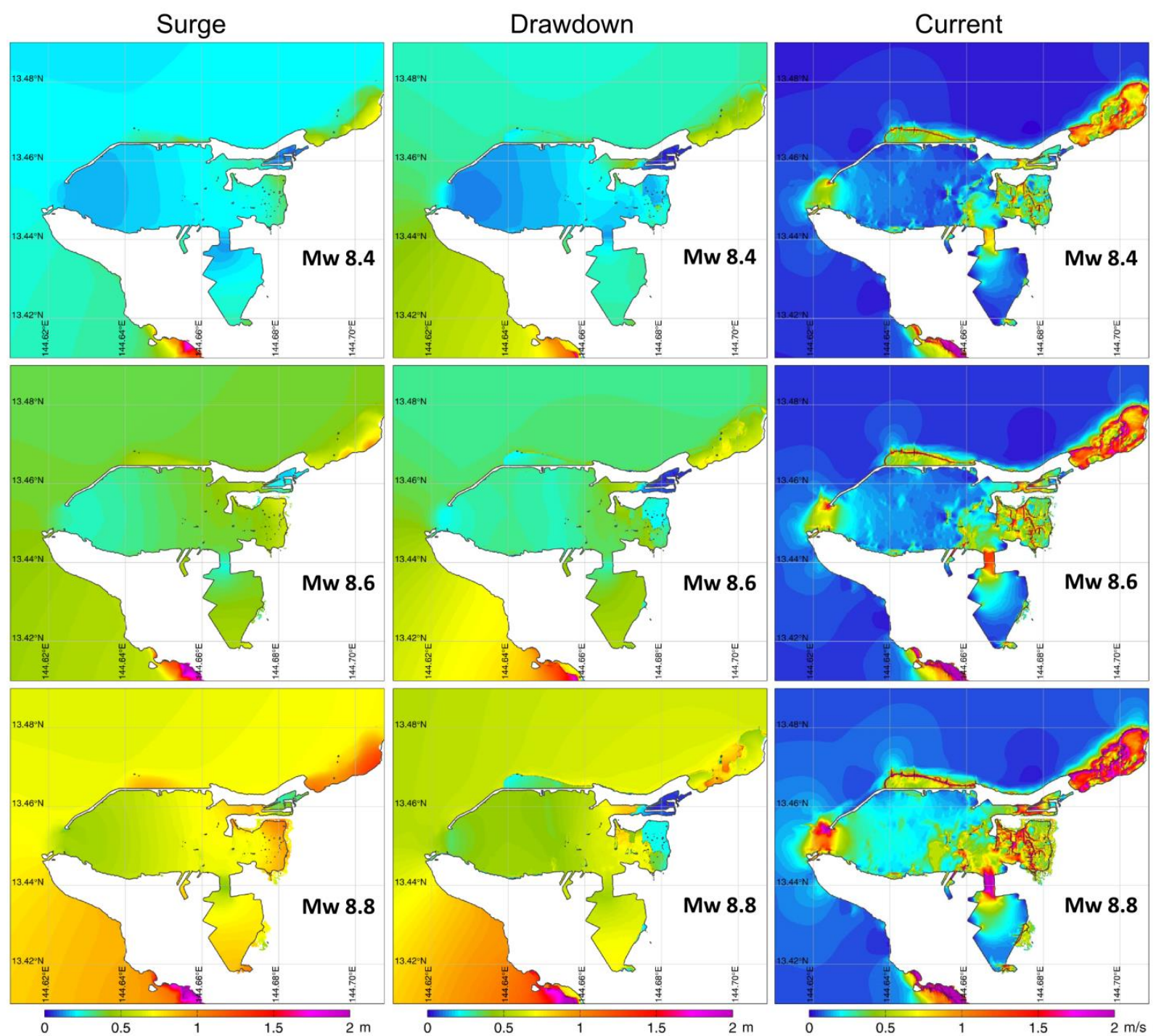
Nankai Trough Earthquake Scenarios



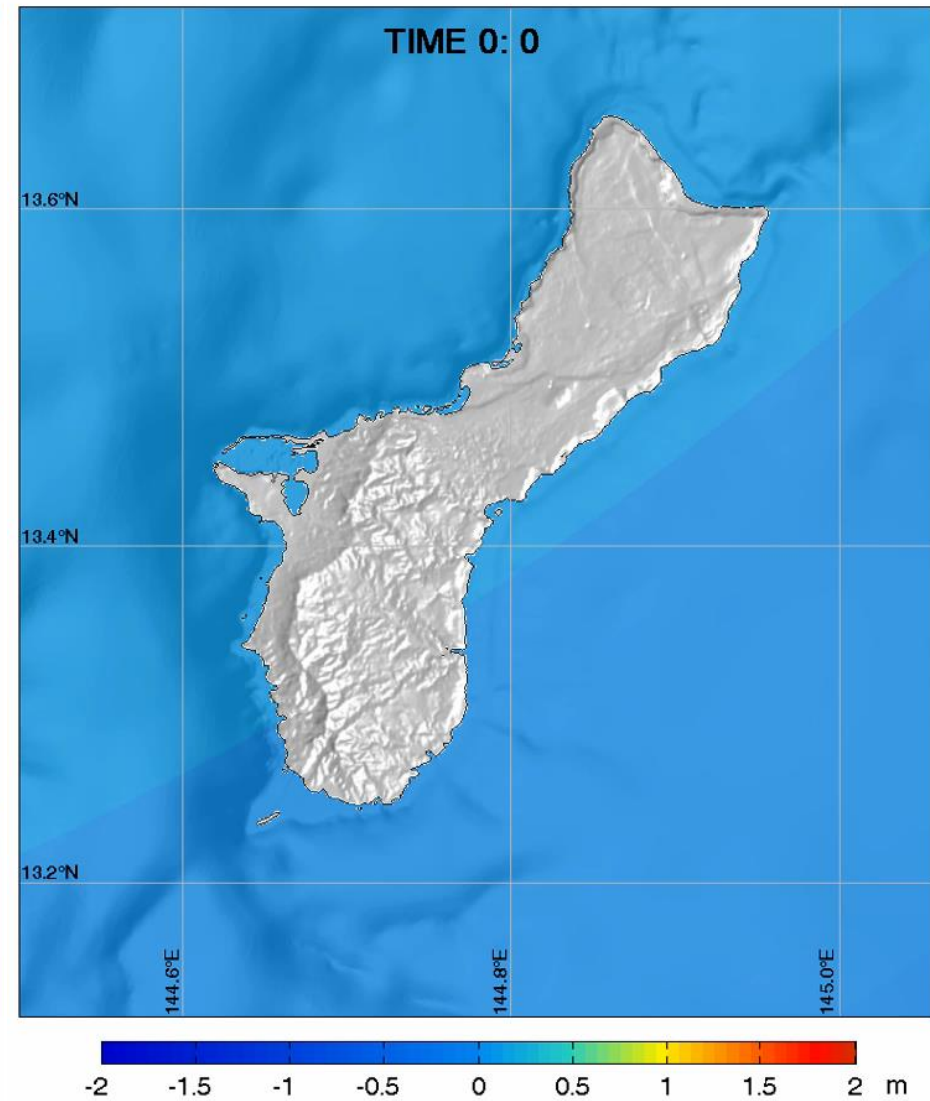
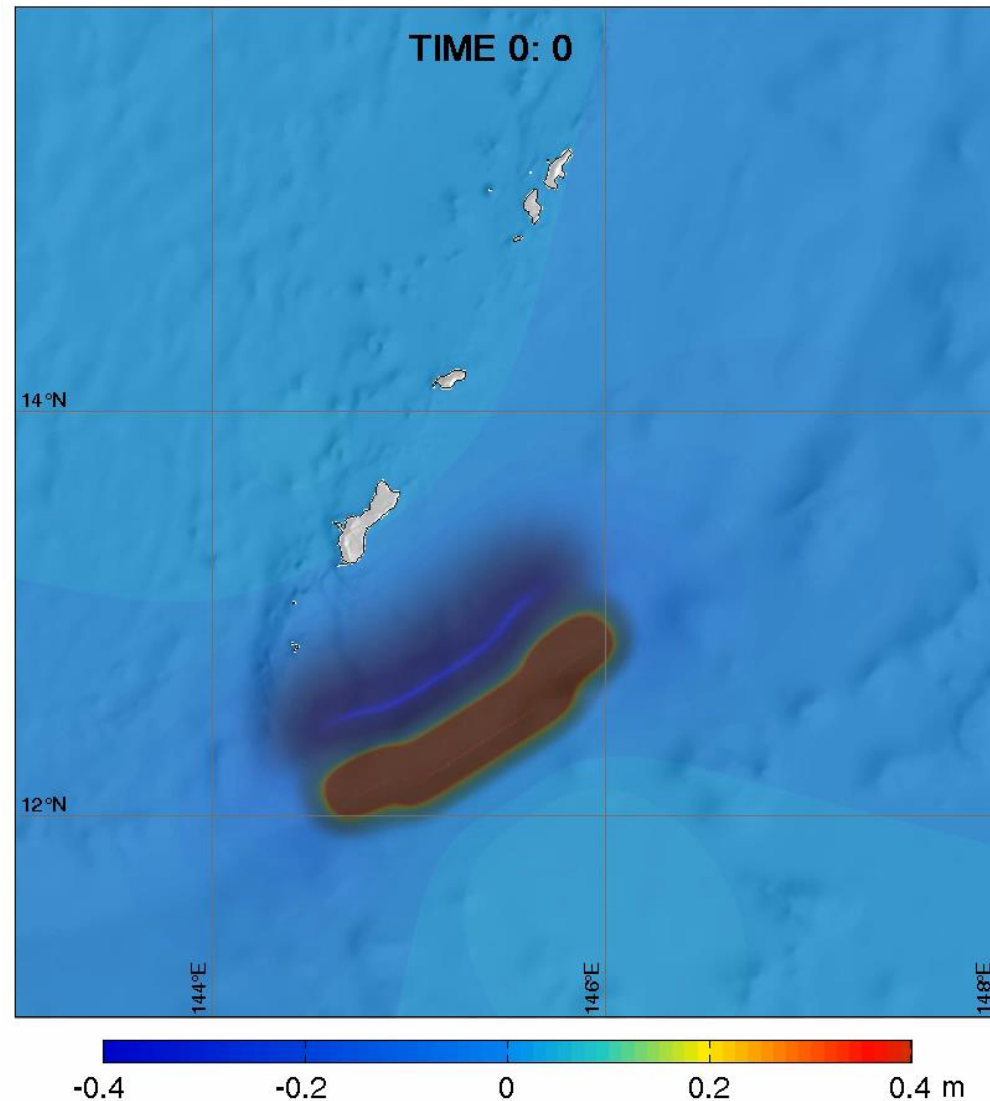
Philippine Trench Earthquake Scenarios



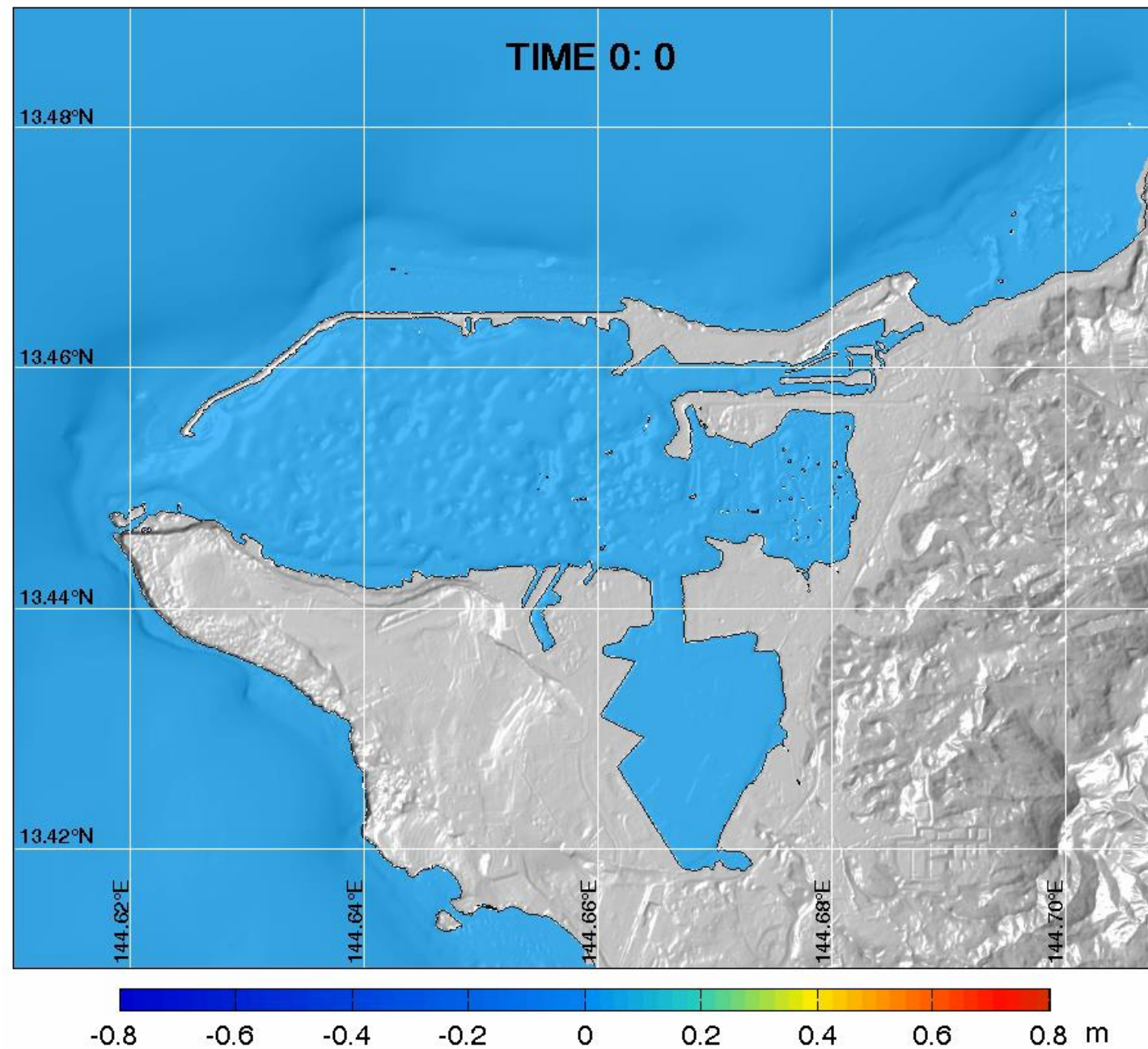
New Guinea Earthquake Scenarios



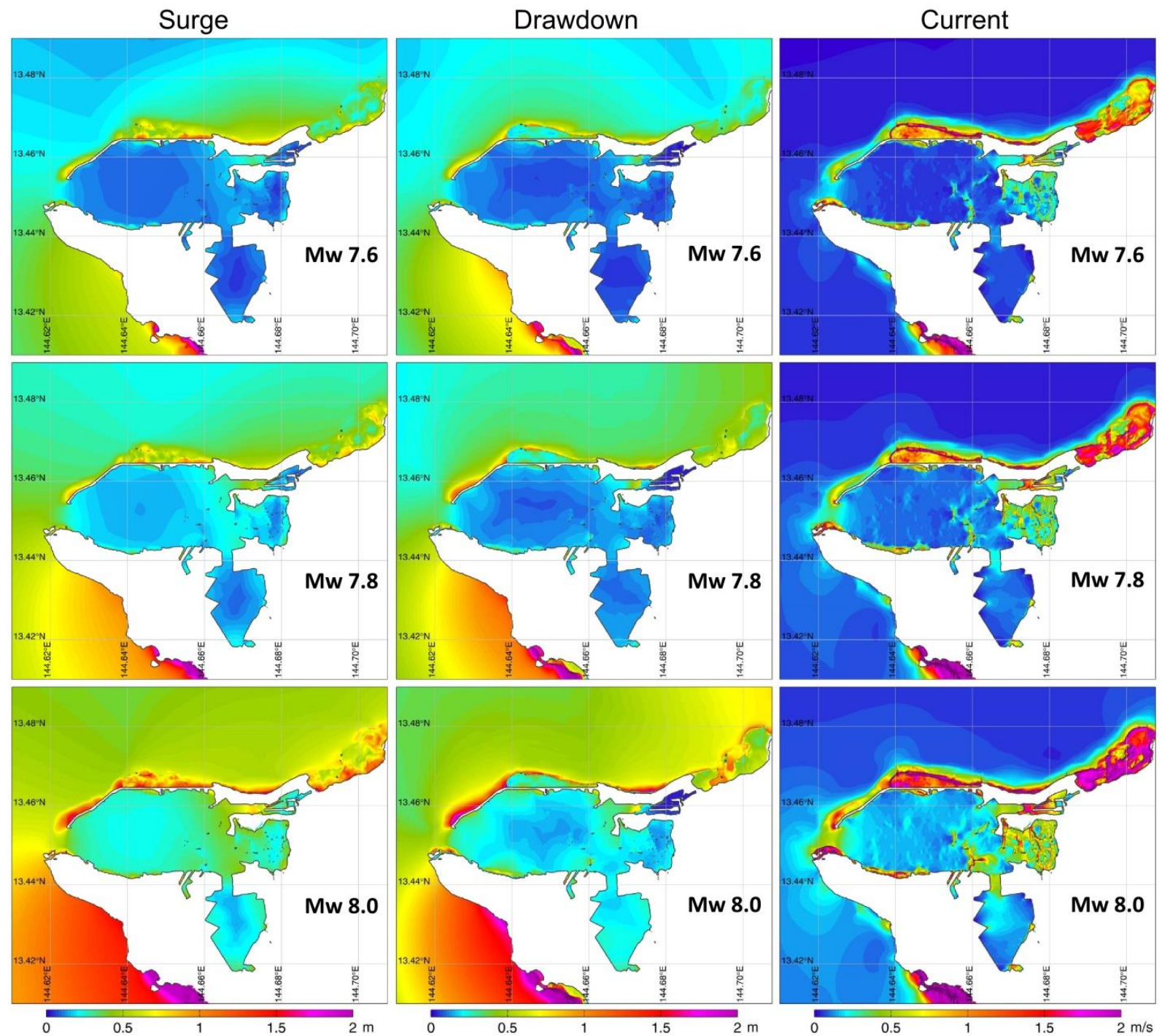
Mw 8.0 Mariana Trench Earthquake Scenario



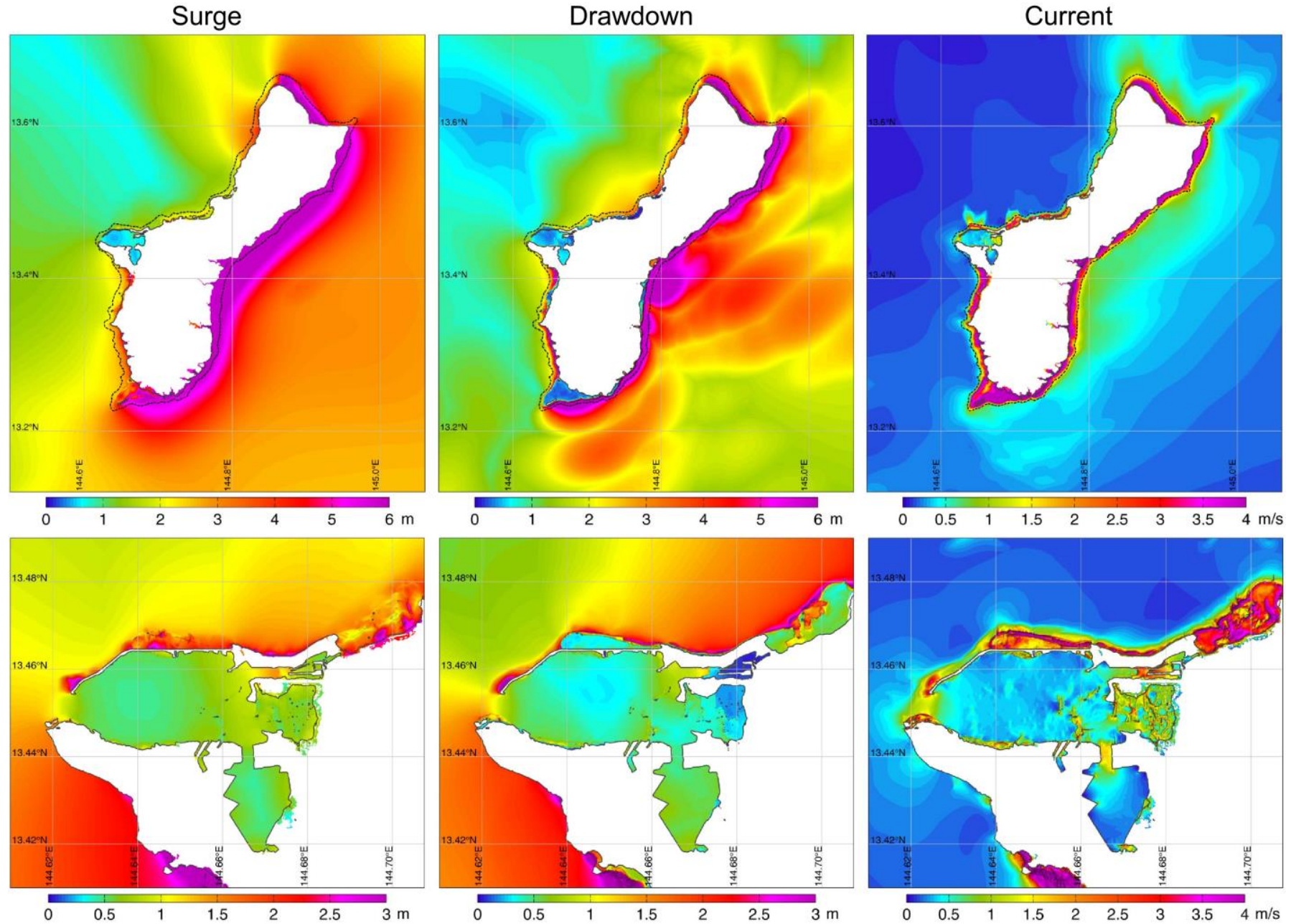
Mw 8.0 Mariana Trench Earthquake Scenario



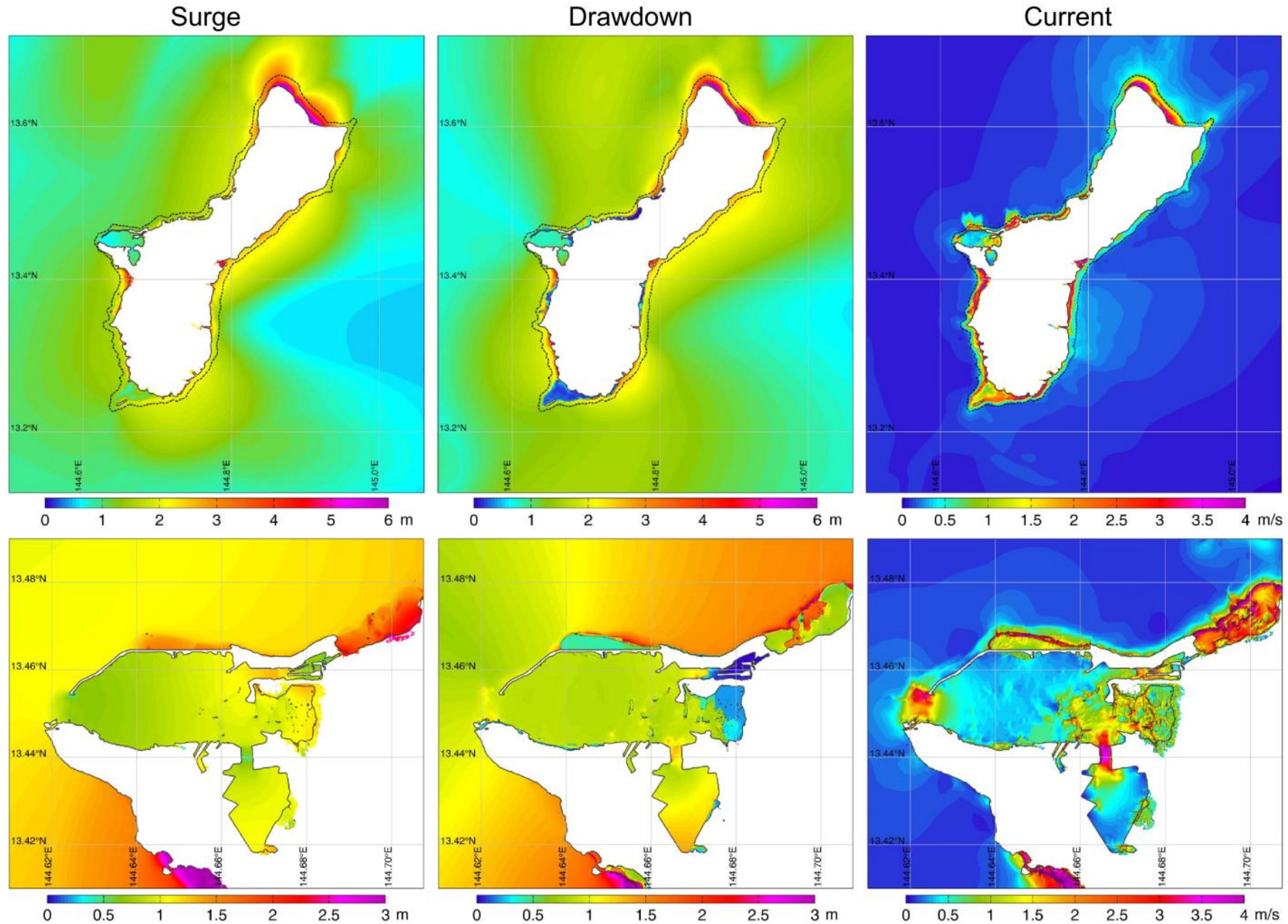
Mariana Trench Earthquake Scenarios



Maximum Mariana Scenario: Guidance for Ship Evacuation



Maximum Philippine Scenario: Guidance for Ship Evacuation



Summary and Continuing Work

Data products include

- In-harbor hazard maps of surge, drawdown, and currents for advisory-level tsunami scenarios from four critical source locations.
- Maps of offshore surge and current for *preferred* maximum tsunamis from the critical source locations

Discussion

- Summary tables for advisory-level scenarios
- Aggregation of maximum scenarios to one set of hazard maps
- Data format: pdf, ArcGIS, Google XML

Continuing and Future work

- Tumon and Agana Bays
- Agat Marina
- Pago Bay

Save-The-Date

- Response Activity Coordinators/Emergency Support Function Coordinators Workshop

Date: 19 Mar 2019

Venue: TBA

- Mitigation Strategies and Opportunities Workshop

Date: 26-27 Mar 2019

Venue: Westin Resort Guam, Tumon

Thank you!

Leo Rustum J Espia

State Hazard Mitigation Officer

Guam Homeland Security/Office of Civil Defense

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